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Information technology — 8 mm wide magnetic tape cartridge for information interchange — Helical scan recording

Technologies de l'information — Cartouche pour bande magnétique de 8 mm de large pour l'échange d'information — Enregistrement par balayage hélicoïdal

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 11319 was prepared by the European Computer Manufacturers Association (as Standard ECMA-145) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology,* Sub-Committee 11, *Flexible magnetic media for digital data interchange,* in parallel with its approval by national bodies of ISO and IEC.

Annexes A, B and C form an integral part of this International Standard. Annexes D and E are for information only.

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Information technology - 8 mm wide magnetic tape cartridge for information interchange - Helical scan recording

Section 1 : General

1 Scope

This International Standard specifies the physical and magnetic characteristics of an 8 mm wide magnetic tape cartridge to enable interchangeability of such cartridges. It also provides a format and recording method, thus allowing, together with ISO 1001 for Magnetic Tape Labelling, full data interchange by means of such magnetic tape cartridges.

2 Conformance

A magnetic tape cartridge shall be in conformance with this International Standard if it satisfies all mandatory requirements specified herein. The tape requirements shall be satisfied throughout the extent of the tape.

3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/R 527:1966, *Plastics - Determination of tensile properties.*

ISO 1001:1986, *Information processing - File structure and labelling of magnetic tapes for information interchange.*

ISO 1302:1978, *Technical drawings - Method of indicating surface texture on drawings.*

IEC 950:1990, *Safety of Information Technology Equipment, including Electrical Business Equipment.*

4 Definitions

For the purpose of this International Standard, the following definitions apply.

4.1 AC erase: A process of erasure utilizing alternating fields of decaying level.

4.2 Average Signal Amplitude: The average peak-to-peak value of the signal output of the read head measured over a minimum of 1,40 mm, exclusive of missing pulses.

4.3 azimuth: The angular deviation, in degrees of arc, of the recorded flux transitions on a track from the line normal to the track centreline.

4.4 back surface: The surface of the tape opposite to the magnetic coating used to record data.

4.5 bit cell: A distance along the track allocated for the recording of a Channel bit.

4.6 byte: An ordered set of bits acted upon as a unit.

4.7 cartridge: A case containing magnetic tape stored on twin reels.

4.8 Cyclic Redundancy Check (CRC) Character: A character used for error detection.

4.9 Error Correcting Code (ECC): A mathematical procedure yielding bytes used for the detection and correction of errors.

4.10 flux transition position: That point which exhibits the maximum free-space flux density normal to the tape surface.

4.11 flux transition spacing: The distance along a track between successive flux transitions.

4.12 magnetic tape: A tape that accepts and retains magnetic signals intended for input, output, and storage of data for information processing.

4.13 Master Standard Reference Tape: A tape selected as the standard for amplitude, Typical Field and Resolution.

NOTE 1 The Master Standard Reference Tape has been established by the SONY Corporation.

4.14 Physical Beginning of Tape (PBOT): The transition from the tape leader to the opaque area of the splice by which the translucent leader tape is joined to the magnetic tape.

4.15 Physical End of Tape (PEOT): The transition from the opaque area of the splice to the translucent trailer tape.

4.16 physical recording density: The number of recorded flux transitions per unit length of track, expressed in flux transitions per millimetre (ftpmm).

4.17 Secondary Reference Amplitude: The Average Signal Amplitude from the Secondary Standard Reference Tape when it is recorded with the Test Recording Current at 2126 ftpmm.

4.18 Secondary Reference Field: The Typical Field of the Secondary Standard Reference Tape.

4.19 Secondary Standard Reference Tape: A tape the performance of which is known and stated in relation to that of the Master Standard Reference Tape.

NOTE 2 Secondary Standard Reference Tapes can be ordered under the Part Number RSE-5001, until the year 2001, from the Sony Corporation, Magnetic Product Group, Data Media Sales Division, 6-7-35 Kitashinagawa, Shinagawa-ku, TOKYO 141, Japan.

It is intended that these be used for calibrating tertiary reference tapes for use in routine calibration.

4.20 Standard Reference Current (Ir): The current that produces the Secondary Reference Field.

4.21 Tape Reference Edge: The lower edge of the tape when the magnetic coating is facing the observer and the supply reel is to the observer's right.

4.22 Test Recording Current: The current that is 1,5 times the Standard Reference Current.

4.23 tone: A signal recorded at 98 ftpmm.

4.24 track: A diagonally positioned area on the tape along which a series of magnetic transitions may be recorded.

4.25 Typical Field: In the plot of the Average Signal Amplitude against the recording field at the physical recording density of 2 126 ftpmm, the minimum field that causes an Average Signal Amplitude equal to 90% of the maximum Average Signal Amplitude.

5 Environment and safety

The conditions specified below refer to ambient conditions immediately surrounding the cartridge. Cartridges exposed to environments outside these limits may still be able to function usefully; however, such exposure may cause permanent damage.

5.1 Testing environment

Unless otherwise specified, tests and measurements made on the cartridge to check the requirements of this International Standard shall be carried out under the following conditions

temperature:	23 °C ± 2 °C
relative Humidity:	40 % to 60 %
conditioning period before testing:	24 h

5.2 Operating environment

Cartridges used for data interchange shall be capable of operating under the following conditions

temperature:	5 °C to 45 °C
relative Humidity:	20 % to 80 %
wet Bulb Temperature:	26 °C max.

There shall be no deposit of moisture on or in the cartridge.

Conditioning before operating:

If a cartridge has been exposed during storage and/or transportation to a condition outside the above values, before use the cartridge shall be conditioned in the operating environment for a time at least equal to the period during which it has been out of the operating environment, up to a maximum of 24 h.

NOTE 3 Rapid variations of temperature should be avoided.

5.3 Storage environment

For long-term or archival storage of cartridges the following conditions shall be observed

temperature:	5 °C to 32 °C
relative Humidity:	20 % to 60 %
wet Bulb Temperature:	26 °C max.

The stray magnetic field at any point on the tape shall not exceed 4 000 A/m. There shall be no deposit of moisture on or in the cartridge.

5.4 Transportation

Recommended limits for the environment to which a cartridge may be subjected during transportation, and the precautions to be taken to minimize the possibility of damage, are provided in annex D.

5.5 Safety

The cartridge and its components shall satisfy the requirements of IEC 950.

5.6 Flammability

The cartridge and its components shall be made from materials which, if ignited from a match flame, do not continue to burn in a still carbon dioxide atmosphere.

Section 2 : Requirements for the case

6 Dimensional and mechanical characteristics of the case

6.1 General

The case of the cartridge shall consist of

- an upper half,
- a lower half,
- a lid pivotally mounted on the upper half.

In the drawings, an embodiment of the cartridge is shown as an example.

Figure 1 is a perspective view of the cartridge seen from the top.

Figure 2 is a perspective view of the cartridge seen from the bottom.

Figure 3 shows the top side with the lid closed using third angle projection.

Figure 4 shows the bottom side, datum and support areas.

Figure 5 shows the bottom side with the lid removed.

Figure 6 shows the enlarged view of the datum and recognition holes.

Figure 7 shows the cross-sections through the light path holes, the recognition holes and the write-inhibit hole.

Figure 8 shows details of the lid when closed, rotating and open.

Figure 9 shows the details of the lid release insertion channel.

Figure 10 shows the lid lock release requirements.

Figure 11 shows the reel lock release requirements.

Figure 12 shows the reel unlock force direction.

Figure 13 shows the lid release force direction.

Figure 14 shows the lid opening force direction.

Figure 15 shows the light path and light window.

Figure 16 shows the internal tape path and light path.

Figure 17 shows the cartridge reel and a cross-section view of the cartridge reel.

Figure 18 shows the cross-section view of the cartridge reel interface with the drive spindle.

Figure 19 shows the tape access cavity clearance requirements.

The dimensions are referred to three orthogonal Reference Planes X, Y and Z.

6.2 Overall dimension (figure 3)

The overall dimensions of the case with the lid in the closed position shall be

L_1 = 62,5 mm ± 0,3 mm

L_2 = 95,0 mm ± 0,2 mm

L_3 = 15,0 mm ± 0,2 mm

The distance from the rear side to plane X shall be

L_4 = 47,35 mm ± 0,15 mm

The distance from the right side to plane Y shall be

L_5 = 13,0 mm ± 0,1 mm

6.3 Holding areas

The holding areas, shown hatched in figure 3, shall be the areas along which the cartridge shall be held down when inserted in the drive. Their position and dimensions shall be

L_6 = 12,0 mm max.

L_7 = 3,0 mm min.

6.4 Cartridge insertion

The cartridge shall have asymmetrical features to prevent insertion in the drive in other than the correct orientation. These consist of a channel, a recess and an incline.

The channel (figures 3 and 9) shall provide for an unobstructed path, when the lid is closed and locked, to unlock the lid. The dimensions shall be

L_8 = 79,7 mm ± 0,2 mm

L_9 = 1,0 mm ± 0,1 mm

L_{10} = 0,7 mm ± 0,1 mm

L_{11} = 1,0 mm min.

L_{12} = 1,2 mm ± 0,1 mm

L_{13} = 0,8 mm ± 0,1 mm

L_{14} = 1,2 mm ± 0,1 mm

L_{15} = 0,5 mm ± 0,1 mm

L_{16} = 1,5 mm ± 0,1 mm

L_{17} = 1,0 mm ± 0,1 mm

L_{18} = 3,8 mm ± 0,1 mm

L_{19} = 0,2 mm ± 0,2 mm

L_{20} = 2,3 mm min.

L_{21} = 2,5 mm ± 0,2 mm

The recess dimensions (figures 3 and 5) shall be

L_{22} = 7,5 mm max.

L_{23} = 11,0 mm ± 0,2 mm

L_{24} = 1,5 mm ± 0,1 mm

L_{25} = 1,5 mm ± 0,1 mm

The incline (figure 8) is part of the lid structure and the dimensions shall be

$L_{26} = 7{,}7\ \text{mm}\ ^{+\,0{,}0}_{-\,2{,}5}\ \text{mm}$

$L_{27} = 0{,}55\ \text{mm}\ ^{+\,0{,}05}_{-\,0{,}10}\ \text{mm}$

A_1 = 17,5° ± 4,0°

6.5 Window (figure 1)

A window may be provided on the top side so that a part of the reel is visible. The window, if provided, shall not extend beyond the height of the cartridge.

6.6 Loading grips (figure 3)

The cartridge shall have loading grips for automatic loading into a drive.

The dimensions and positions of the loading grips shall be

L_{28} = 39,35 mm ± 0,20 mm

L_{29} = 1,5 mm ± 0,1 mm

L_{30} = 5,0 mm ± 0,3 mm

L_{31} = 2,0 mm ± 0,2 mm

A_2 = 90° ± 5°

6.7 Label areas (figure 3)

A portion of the rear side of the cartridge and a portion of the top side of the cartridge may be used for labels. The rear side area provides for readability of the label when it is stacked or inserted into the drive. The position and the size of the labels shall not interfere with the operation or clearance requirements of the cartridge component parts.

The area used for labels on the top side shall not extend beyond the inner edge of the holding areas defined by L_6 and L_7.

The position and dimensions of the rear side label area shall be

L_{32} = 0,5 mm min.

L_{33} = 1,5 mm min.

L_{34} = 80,0 mm max.

The depth of the label depression shall be 0,3 mm max.

6.8 Datum areas and datum holes (figures 4, 5 and 6)

The annular datum areas A, B and C shall lie in plane Z. They determine the vertical position of the cartridge in the drive. Each shall have a diameter D_1 equal to 6,0 mm ± 0,1 mm and be concentric with the respective datum hole.

The centres of datum holes A and B lie in plane X.

The centre of the circular datum hole A shall be at the intersection of planes X and Y (see figure 5).

The distance from the centre of datum hole B to plane Y (see figure 4) shall be

L_{35} = 68,0 mm ± 0,1 mm

The distance from the centre of the circular datum hole C to plane Y (see figure 6) shall be

L_{36} = 10,20 mm ± 0,05 mm

The distance from the centre of datum hole D to plane Y (see figure 6) shall be

L_{37} = 79,2 mm ± 0,1 mm

The distance from the centres of datum holes C and D to plane X (see figure 5) shall be

L_{38} = 36,35 mm ± 0,08 mm

The diameter of datum hole A and datum hole C shall be 3,00 mm $^{+0,05}_{-0,00}$ mm. The dimensions of datum hole A and datum hole C shall be

$L_{39} = 1{,}2\ \text{mm}\ {}^{+\,1{,}0}_{-\,0{,}0}\ \text{mm}$

$L_{40} = 2{,}6$ mm min.

$L_{41} = 1{,}5$ mm min.

$L_{42} = 4{,}0$ mm min.

$L_{43} = 0{,}3$ mm max.

$A_3 = 45° \pm 1°$

The dimensions of datum hole B and datum hole D shall be

$L_{39} = 1{,}2\ \text{mm}\ {}^{+\,1{,}0}_{-\,0{,}0}\ \text{mm}$

$L_{40} = 2{,}6$ mm min.

$L_{41} = 1{,}5$ mm min.

$L_{42} = 4{,}0$ mm min.

$L_{43} = 0{,}3$ mm max.

$L_{44} = 3{,}00\ \text{mm}\ {}^{+\,0{,}05}_{-\,0{,}00}\ \text{mm}$

$L_{45} = 3{,}5$ mm $\pm$ 0,1 mm

$L_{46} = 3{,}00$ mm $\pm$ 0,05 mm

$A_3 = 45° \pm 1°$

$R_1 = 1{,}7$ mm min.

6.9 Support areas

The cartridge support areas are shown shaded in figure 4. Support areas A, B and C shall be coplanar with datum areas A, B and C, respectively, within ± 0,1 mm. Support area D shall be coplanar with datum plane Z within ± 0,15 mm.

The areas within L_{49} of the edge of the cartridge shall be recessed from the support areas.

The dimensions and positions of the support areas shall be

$L_{35} = 68{,}0$ mm $\pm$ 0,1 mm

$L_{47} = 10{,}0$ mm $\pm$ 0,1 mm

$L_{48} = 11{,}0$ mm $\pm$ 0,1 mm

$L_{49} = 0{,}5$ mm $\pm$ 0,1 mm

$L_{50} = 7{,}0$ mm $\pm$ 0,1 mm

$L_{51} = 30{,}0$ mm $\pm$ 0,1 mm

$L_{52} = 5{,}5$ mm $\pm$ 0,1 mm

$L_{53} = 64{,}5$ mm $\pm$ 0,2 mm

6.10 Recognition holes (figures 5, 6 and 7)

There shall be 5 recognition holes numbered 1 to 5 as shown in figure 6.

Their positions shall be defined by

L_{54} = 43,35 mm ± 0,15 mm

L_{55} = 3,7 mm ± 0,1 mm

L_{56} = 2,3 mm ± 0,1 mm

L_{57} = 6,4 mm ± 0,1 mm

L_{58} = 3,7 mm ± 0,1 mm

L_{59} = 2,3 mm ± 0,1 mm

L_{60} = 6,4 mm ± 0,1 mm

L_{61} = 79,0 mm ± 0,2 mm

All recognition holes shall have the cross-section F-F shown in figure 7 and shall have a diameter of 3,0 mm ± 0,1 mm

$L_{62} = 1{,}2\ \text{mm}\ {}^{+0{,}3}_{-0{,}1}\ \text{mm}$

L_{63} = 5,0 mm min.

One of the cross-sections shows a recognition hole closed by a plug, the other shows the plug punched out. These plugs shall withstand an applied force of 0,5 N max without being punched out.

This International Standard prescribes the following states of these holes.

- Recognition hole 1 shall be closed.
- Recognition hole 2 shall be closed for tape of 13 µm nominal thickness.
- Recognition hole 2 shall be open for tape of 10 µm nominal thickness.
- Recognition holes 3, 4 and 5 shall be closed.

6.11 Write-inhibit Hole (figures 6 and 7)

The position and dimension of the Write-inhibit Hole shall be defined by

L_{55} = 3,7 mm ± 0,1 mm

$L_{62} = 1{,}2\ \text{mm}\ {}^{+0{,}3}_{-0{,}1}\ \text{mm}$

L_{63} = 5,0 mm min.

L_{64} = 10,0 mm ± 0,1 mm

The diameter of the hole shall be 3,0 mm ± 0,1 mm

When the Write-inhibit Hole is open, recording on the tape is inhibited. When it is closed, recording is enabled.

The case may have a movable element allowing the Write-inhibit Hole to be opened or closed. If present, this element shall be such that the state of the Write-inhibit Hole shall be visible (see figure 3 as an example). The Write-inhibit hole closure shall be constructed to withstand a force of 0,5 N. The force required to open or close the Write-inhibit Hole shall be between 1 N and 15 N.

6.12 Pre-positioning surfaces (figures 3 and 5)

These surfaces determine the position of the cartridge in the Y direction when inserted into the drive loading slot.

The dimensions of the pre-positioning surfaces shall be

L_{25} = 1,5 mm ± 0,1 mm

$L_{65} = 2{,}4 \text{ mm} \begin{smallmatrix} +0{,}0 \\ -0{,}1 \end{smallmatrix} \text{ mm}$

$L_{66} = 2{,}4 \text{ mm} \begin{smallmatrix} +0{,}0 \\ -0{,}1 \end{smallmatrix} \text{ mm}$

L_{67} = 1,0 mm ± 0,1 mm

L_{68} = 69,0 mm ± 0,2 mm

L_{69} = 14,65 mm ± 0,10 mm

L_{70} = 13,15 mm ± 0,10 mm

A_4 = 45° ± 1°

6.13 Cartridge lid (figures 3 and 8)

The cartridge shall include a lid for protection of the tape during handling, storage and transportation. The lid consists of two parts, the main part and an auxiliary part.

The main part rotates around axis A (see figure 8) which is fixed relative to the case.

The location of axis A shall be defined by L_{27} and

L_{71} = 7,5 mm ± 0,1 mm

The auxiliary part rotates around axis B which is fixed relative to the main part of the lid and moves with it. When the lid is in the closed position, the location of axis B shall be defined by

L_{72} = 7,0 mm ± 0,1 mm

L_{73} = 10,1 mm ± 0,1 mm

The rotation of the auxiliary part is controlled, by a cam at each end, to give the path indicated in figure 8.

When the lid is completely open, neither part shall extend above a plane located L_{77} above and parallel to plane Z.

L_{74} = 14,8 mm min.

L_{75} = 11,5 mm ± 0,2 mm

L_{76} = 1,2 mm ± 0,1 mm

L_{77} = 22,3 mm max.

A_5 = 85° ± 2°

When the lid is in a partially open position, neither part shall extend above a plane located L_{78} above and parallel to plane Z.

L_{78} = 22,5 mm max.

R_2 = 14,9 mm max.

The main part is shown in figures 3 and 8.

L_{71} = 7,5 mm ± 0,1 mm

L_{79} = 8,4 mm max.

$L_{80} = 15{,}2 \text{ mm } {}^{+0{,}0}_{-0{,}5} \text{ mm}$

$L_{81} = 15{,}3 \text{ mm } {}^{+0{,}0}_{-0{,}3} \text{ mm}$

$L_{82} = 13{,}15 \text{ mm} \pm 0{,}10 \text{ mm}$

$R_3 = 14{,}7 \text{ mm } {}^{+0{,}0}_{-0{,}3} \text{ mm}$

The design of the locking mechanism is not specified by this International Standard except that it shall be operated by a release pin in the drive. In the lid closed and locked position, access to the lid lock release shall be unobstructed in the hatched area (see figure 10) defined by

$L_{83} = 2{,}0 \text{ mm} \pm 0{,}1 \text{ mm}$

$L_{84} = 6{,}3 \text{ mm} \pm 0{,}2 \text{ mm}$

$L_{85} = 1{,}2 \text{ mm} \pm 0{,}1 \text{ mm}$

$A_6 = 45° \pm 1°$

$A_7 = 15° \pm 1°$

The lid release mechanism shall be actuated when the drive release pin is in the shaded area (see figure 10) defined by

$L_{83} = 2{,}0 \text{ mm} \pm 0{,}1 \text{ mm}$

$L_{86} = 8{,}2 \text{ mm} \pm 0{,}2 \text{ mm}$

$L_{87} = 0{,}7 \text{ mm} \pm 0{,}2 \text{ mm}$

$A_8 = 15° \pm 1°$

The force needed to unlock the lid lock shall not exceed 0,25 N in the direction shown in figure 13.

The force needed to open the lid shall not exceed 1,0 N in the direction shown in figure 14.

6.14 Cartridge reel lock (figure 11)

The reels shall be locked when the cartridge is removed from the tape drive. The design of the locking mechanism is not specified by this International Standard except that it shall be operated by a release pin in the drive.

The release mechanism shall be accessed through a hole in the case (see figure 5) defined by

$L_{88} = 34{,}5 \text{ mm} \pm 0{,}1 \text{ mm}$

$L_{89} = 35{,}85 \text{ mm} \pm 0{,}15 \text{ mm}$

$L_{90} = 4{,}0 \text{ mm} \pm 0{,}1 \text{ mm}$

$L_{91} = 6{,}5 \text{ mm min.}$

The reels shall be unlocked when the operating face of the release pin is located L_{95} from plane X. In this position there shall be a clearance of L_{96} between the locking mechanism and the inside of the rear wall of the cartridge.

The dimensions of the release mechanism (see figure 11) shall be

L_{92} = 3,2 mm $^{+0,3}_{-0,2}$ mm

L_{93} = 4,0 mm ± 0,1 mm

L_{94} = 39,0 mm $^{+2,0}_{-0,0}$ mm

L_{95} = 41,75 mm $^{+0,50}_{-0,00}$ mm

L_{96} = 0,5 mm min.

L_{97} = 7,8 mm max.

L_{98} = 4,0 mm ± 0,1 mm

A_9 = 60,0° ± 1,0°

R_4 = 0,3 mm max.

The force needed to unlock the reel lock in the direction shown in figure 12 shall not exceed 1,0 N.

6.15 Reel access holes (figure 5)

The case shall have two circular reel access holes which shall allow penetration of the drive spindles.

The dimension and positions of the access holes shall be

L_{99} = 23,00 mm ± 0,05 mm

L_{100} = 11,40 mm ± 0,05 mm

L_{101} = 46,2 mm ± 0,1 mm

D_2 = 18,80 mm ± 0,05 mm

6.16 Interface between the reels and the drive spindles (figures 17 and 18)

The drive spindles shall engage the reels in the area defined by

L_{102} = 5,4 mm ± 0,1 mm

L_{103} = 4,4 mm ± 0,1 mm

L_{104} = 0,6 mm max.

L_{105} = 2,4 mm ± 0,1 mm

L_{106} = 0,2 mm max.

L_{107} = 2,4 mm ± 0,2 mm

A_{10} = 45° ± 1°

A_{11} = 15° ± 1°

A_{12} = 60° ± 1°

R_5 = 0,2 mm max.

$D_3 = 6{,}50 \text{ mm} \begin{smallmatrix} +\ 0{,}08 \\ -\ 0{,}00 \end{smallmatrix} \text{ mm}$

$D_4 = 10{,}00 \text{ mm} \begin{smallmatrix} +\ 0{,}08 \\ -\ 0{,}00 \end{smallmatrix} \text{ mm}$

$D_5 = 16{,}0$ mm max.

$D_6 = 18{,}0 \text{ mm} \begin{smallmatrix} +\ 0{,}0 \\ -\ 0{,}1 \end{smallmatrix} \text{ mm}$

Depth L_{108} of reel driving hole shall be effective to the diameter D_3 .

$L_{108} = 9{,}4$ mm min.

The reel spring force F shall be 0,6 N ± 0,2 N in the direction shown in figure 18 when the cartridge is mounted in the drive and the support area is L_{110} from datum plane Z.

$L_{109} = 7{,}05$ mm ± 0,10 mm

$L_{110} = 0{,}6$ mm ± 0,2 mm

$L_{111} = 7{,}5$ mm max.

$L_{112} = 8{,}0$ mm max.

$A_{13} = 60° \pm 1°$

6.17 Light path (figures 5, 7, 15 and 16)

A light path shall be provided for sensing the leader and trailer tapes. When the lid is open, an unobstructed light path shall exist from the D_7 diameter light path hole to the outside of the cartridge via square holes of side L_{116} (see cross-section D-D in figure 7) and the light window in the cartridge lid.

$L_{88} = 34{,}5$ mm ± 0,1 mm

$L_{113} = 8{,}35$ mm ± 0,10 mm

$L_{114} = 0{,}5$ mm max.

$L_{115} = 6{,}05$ mm ± 0,10 mm

$L_{116} = 2{,}5$ mm ± 0,4 mm

$L_{117} = 12{,}5$ mm min.

$L_{118} = 3{,}8$ mm ± 0,1 mm

$L_{119} = 2{,}5$ mm ± 0,4 mm

$L_{120} = 6{,}05$ mm ± 0,10 mm

$A_{14} = 45° \pm 1°$

$A_{15} = 5{,}50° \pm 0{,}25°$

$D_7 = 6{,}5 \text{ mm} \begin{smallmatrix} +\ 0{,}3 \\ -\ 0{,}0 \end{smallmatrix} \text{ mm}$

6.18 Position of the tape in the case (figure 16)

The tape shall run between two guide surfaces in a plane parallel to datum plane X and L_{121} from it.

$L_{121} = 12{,}46$ mm ± 0,10 mm

The guide surfaces shall have a radius of R_6 and shall be tangential, as shown in figure 16, to lines tangential to the reel hubs that extend to points outside the case . These points shall be defined by

L_{122} = 76,28 mm ± 0,30 mm

L_{123} = 27,15 mm ± 0,20 mm

L_{124} = 31,15 mm ± 0,20 mm

L_{125} = 9,67 mm ± 0,10 mm

R_6 = 1,5 mm min.

6.19 Tape path zone (figures 16 and 17)

When the cartridge is inserted into the drive, the tape is pulled outside the case by tape guides and is no longer in contact with the guide surfaces. The tape path zone of the case is the zone in which the tape shall be able to move freely. This zone shall be maintained for both sides of the case and shall be defined by

L_{122} = 76,28 mm ± 0,30 mm

L_{123} = 27,15 mm ± 0,20 mm

L_{124} = 31,15 mm ± 0,20 mm

L_{125} = 9,67 mm ± 0,10 mm

L_{126} = 23,0 mm ± 0,1 mm

L_{127} = 0,3 mm min.

L_{128} = 46,2 mm ± 0,2 mm

L_{129} = 11,4 mm ± 0,1 mm

L_{130} = 0,3 mm min.

$D_8 = 16{,}05\ \text{mm}\ ^{+0{,}00}_{-0{,}10}\ \text{mm}$

6.20 Tape access cavity (figure 5)

When the cartridge is inserted into the drive, tape guides in the drive pull out the tape into the drive tape path. The shape and dimensions of the access cavity for these tape guides shall be defined as follows. The two radii R_7 are centred on datum holes A and B.

R_7 = 2,3 mm ± 0,1 mm

The two radii R_8 are centred on the centres of the reel access holes.

R_8 = 24,15 mm ± 0,10 mm

L_{67} = 1,0 mm ± 0,1 mm

L_{68} = 69,0 mm ± 0,2 mm

L_{131} = 3,81 mm ± 0,10 mm

6.21 Tape access cavity clearance requirements (figure 19)

The case design shall provide clearance for drive tape threading mechanisms and shall be

L_{132} = 1,2 mm max.

$L_{133} = 1{,}15\ \text{mm}\ ^{+0{,}20}_{-0{,}00}\ \text{mm}$

$L_{134} = 14{,}0 \text{ mm } {}^{+0{,}0}_{-0{,}2} \text{ mm}$

L_{135} = 66,8 mm min.

L_{136} = 10,0 mm min.

A_{16} = 49° max.

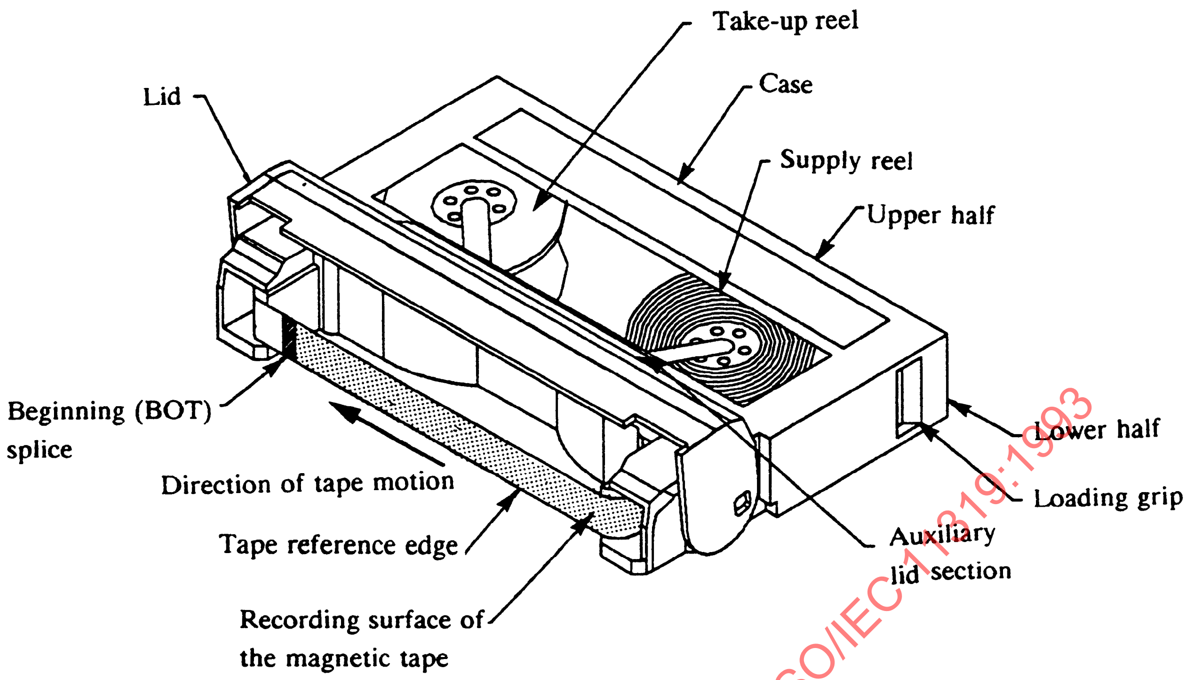

Figure 1 - Tape cartridge assembly bottom view (lid open)

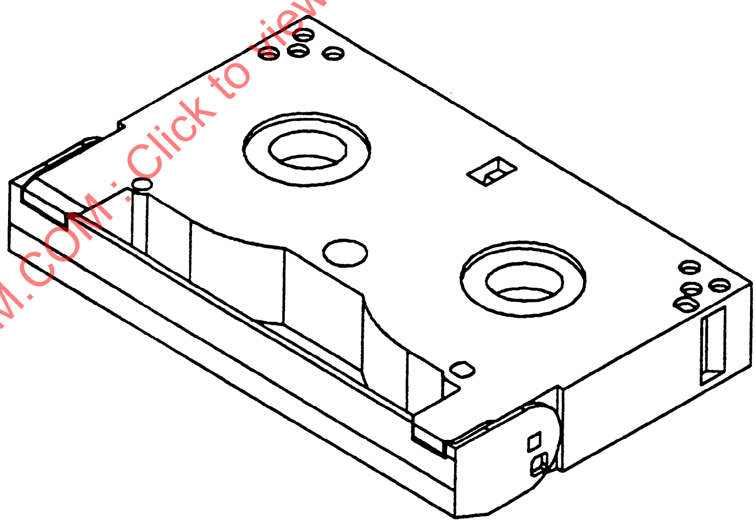

Figure 2 - Tape cartridge assembly bottom view (lid closed)

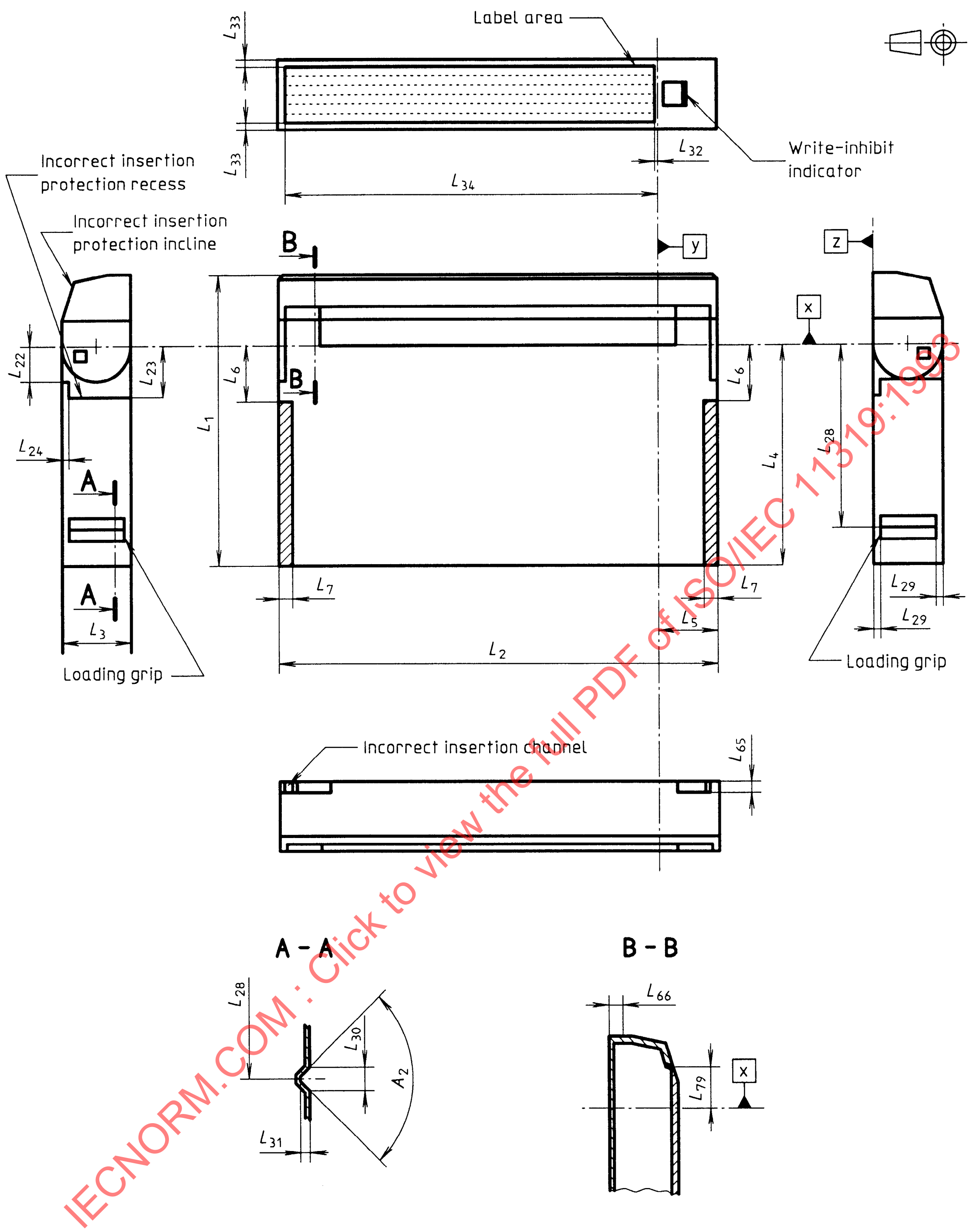

Figure 3 - Top side (lid closed)

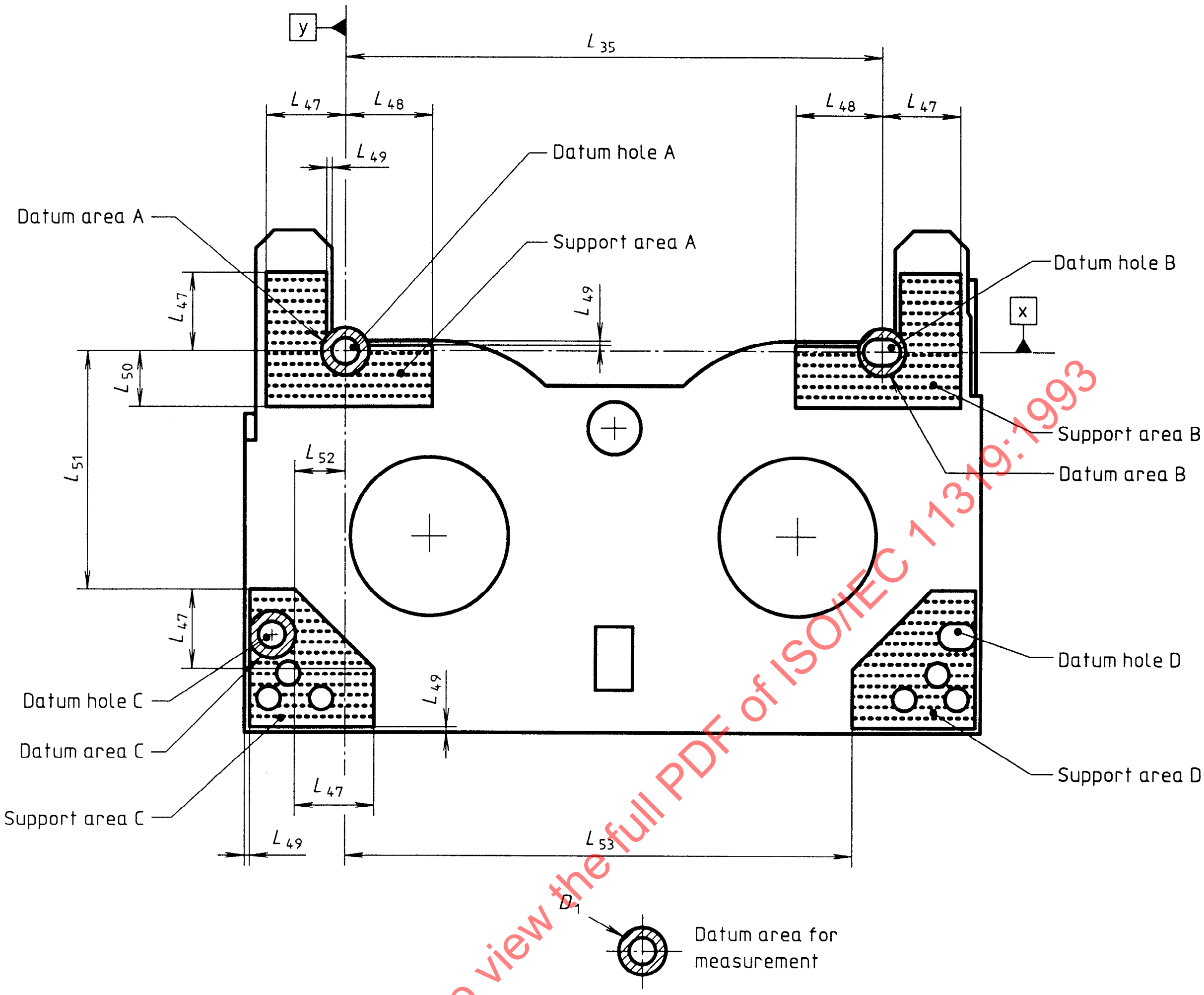

Figure 4 - Bottom side, datum and support areas

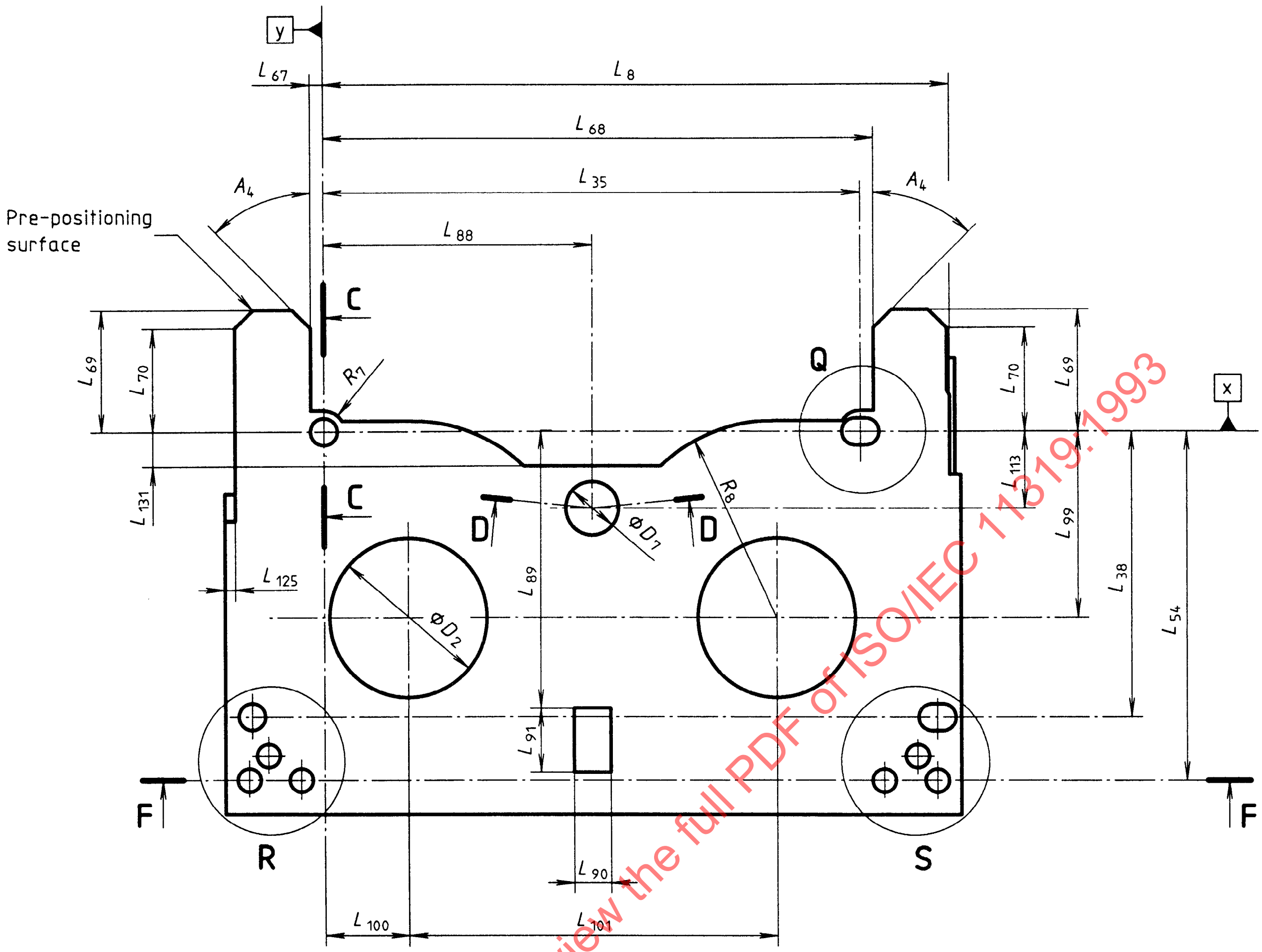

Figure 5 - Bottom side (lid removed)

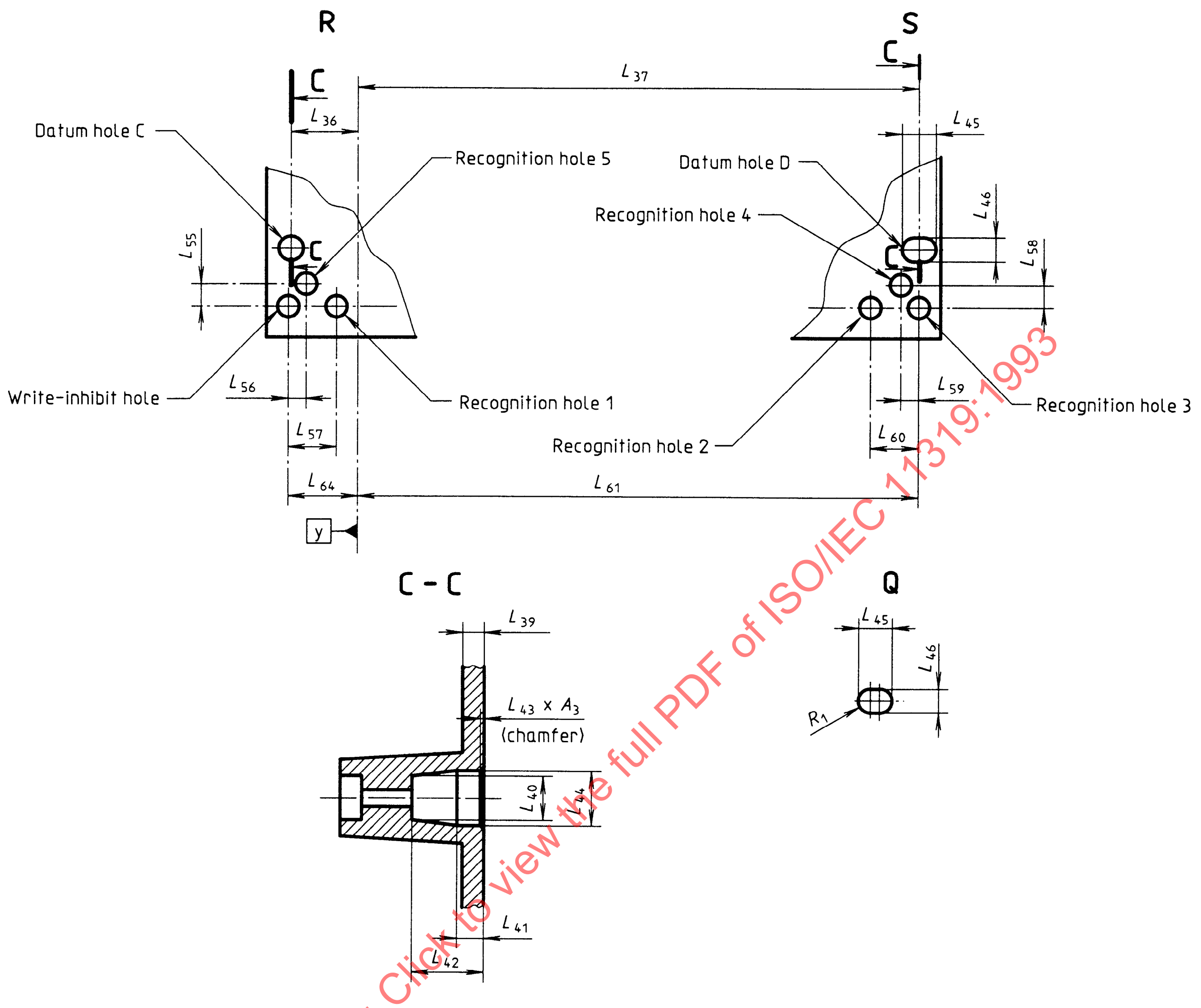

Figure 6 - Details of datum and recognition holes

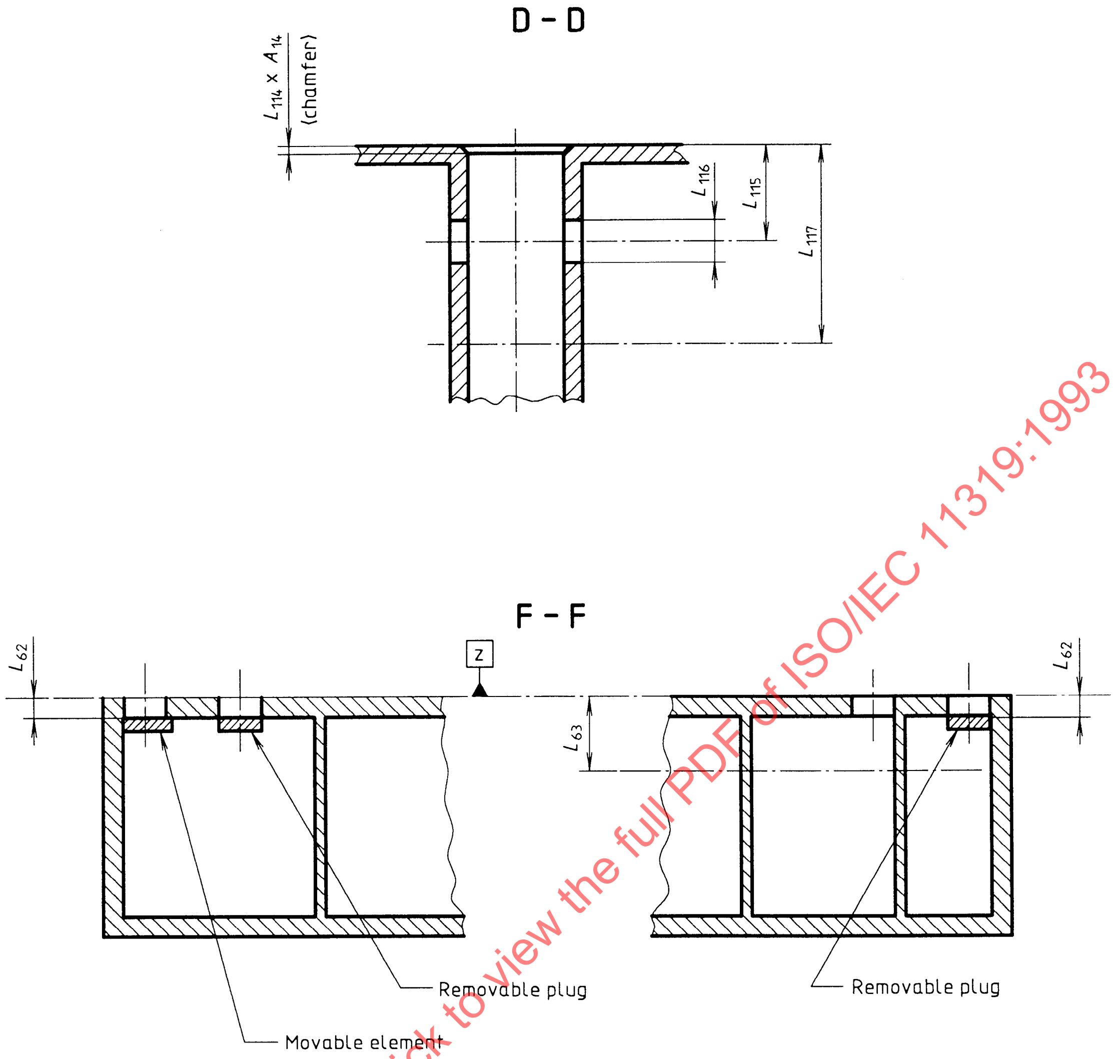

Figure 7 - Cross-sections of light path holes, recognition holes and write-inhibit hole

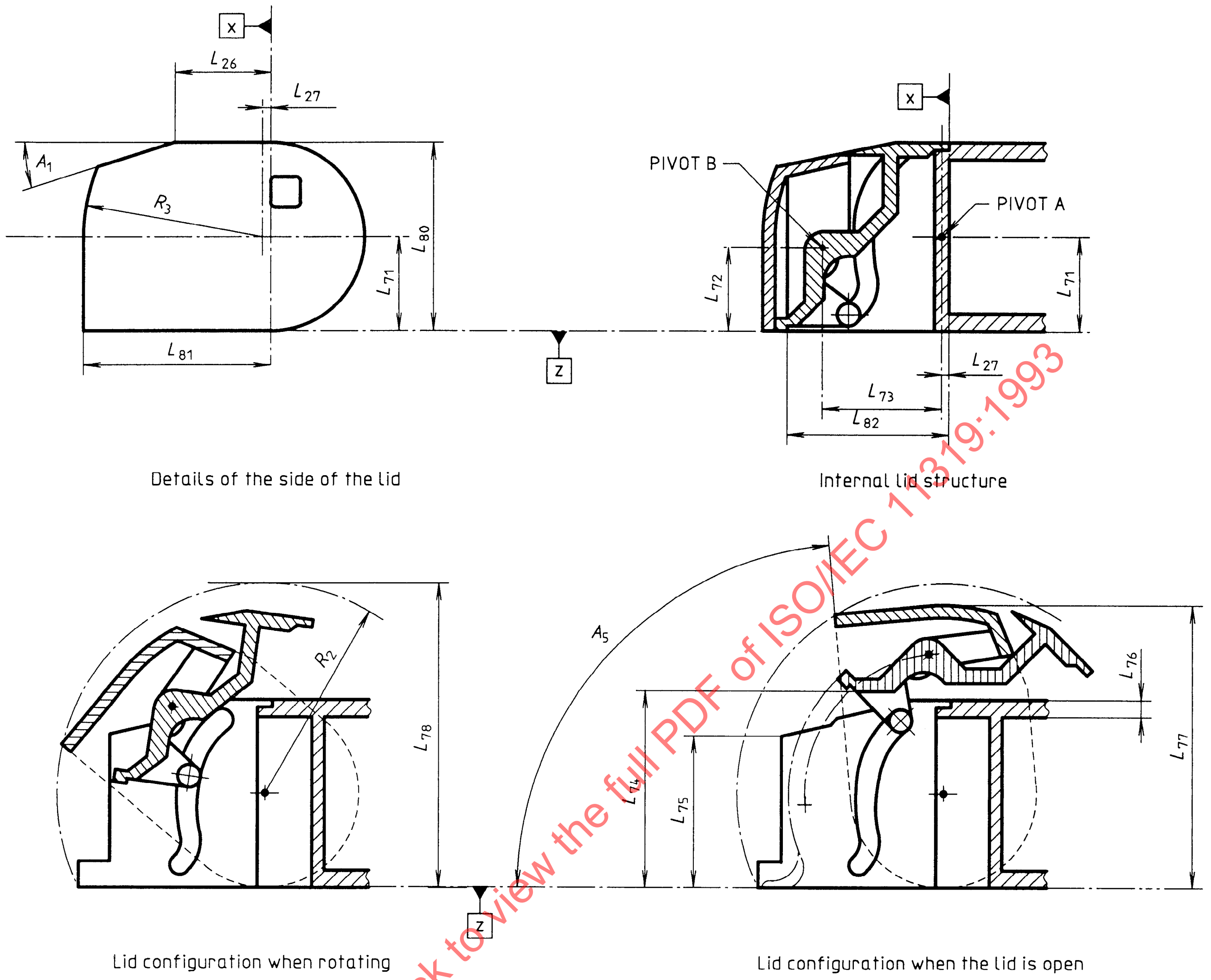
X
L_{26}
L_{27}
A_1
R_3
L_{80}
L_{71}
L_{81}
Z
PIVOT B
PIVOT A
L_{72}
L_{73}
L_{82}
Details of the side of the lid
Internal lid structure
R_2
L_{78}
A_5
L_{74}
L_{75}
L_{76}
L_{77}
Lid configuration when rotating
Lid configuration when the lid is open

Figure 8 - Lid

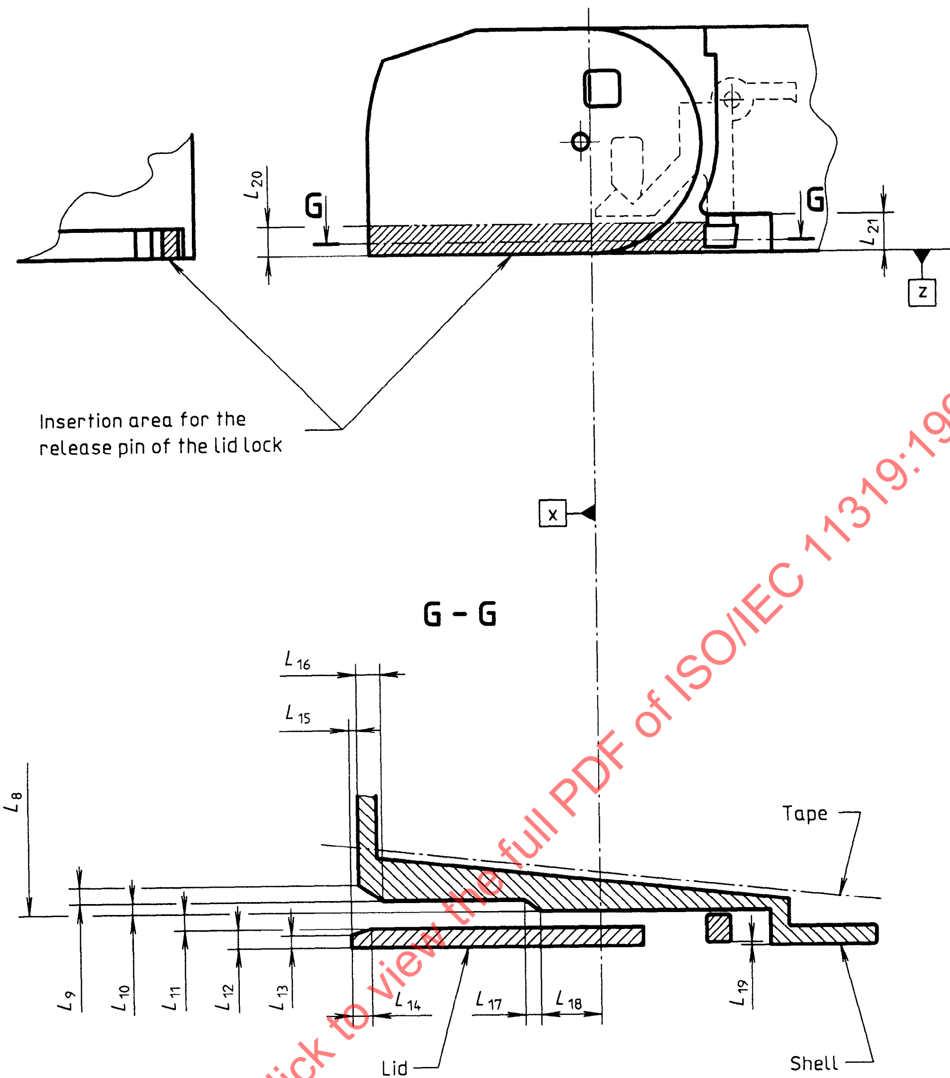

Figure 9 - Lid release insertion channel

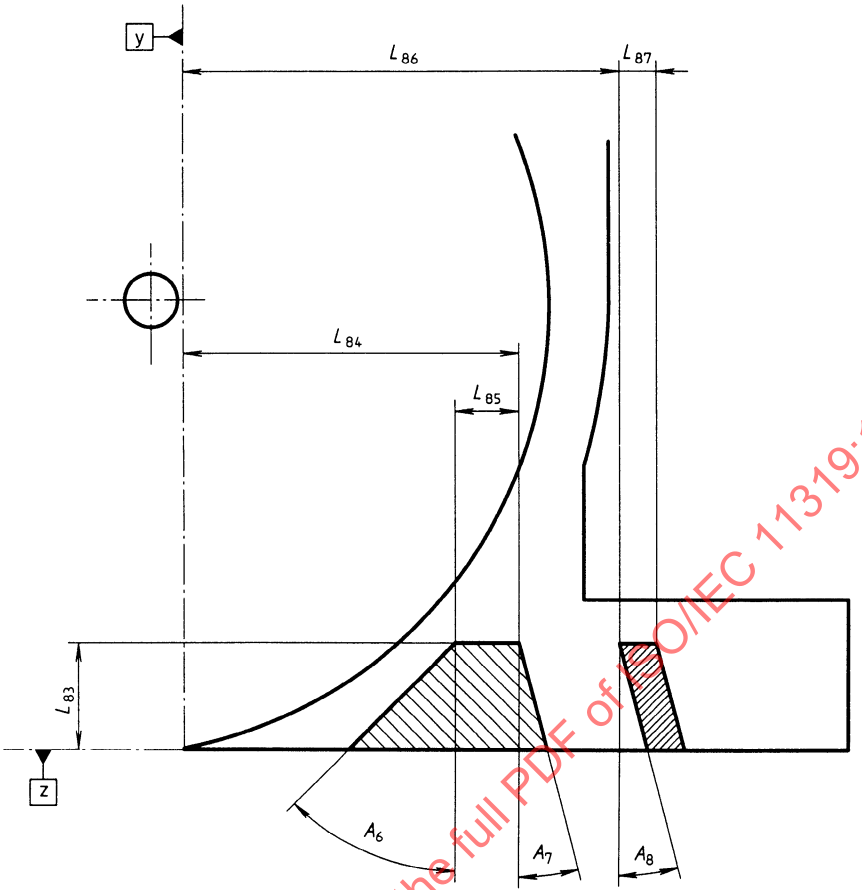

Figure 10 - Lid release requirement

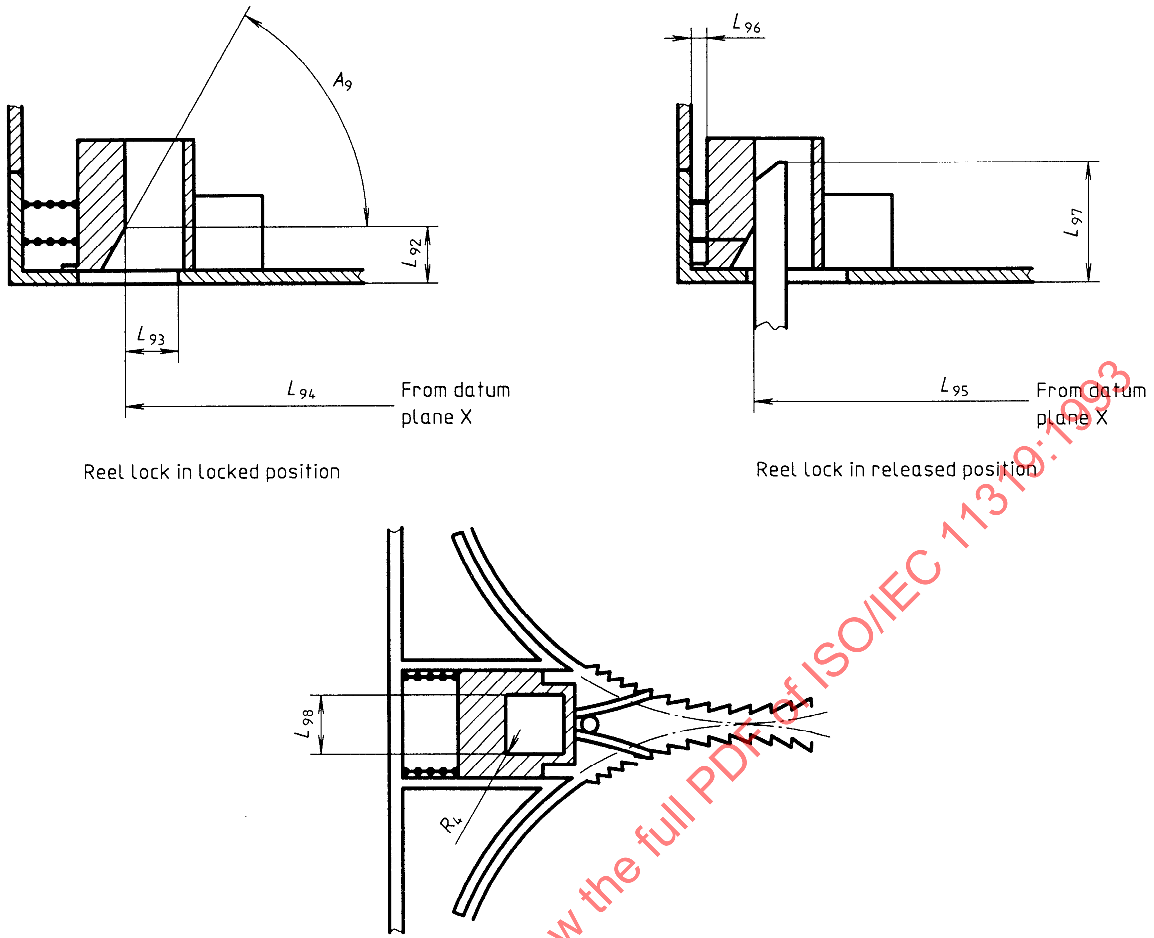

Figure 11 - Reel lock release

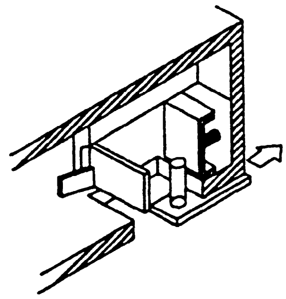

Figure 12 - Direction of force needed to unlock the reel lock

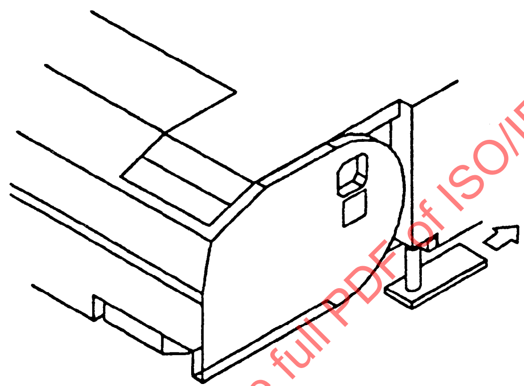

Figure 13 - Direction of force needed to unlock the lid lock

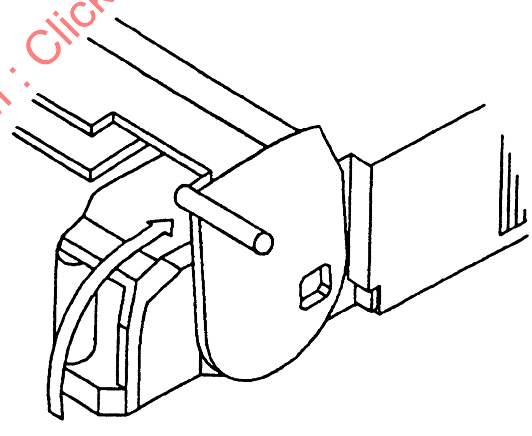

Figure 14 - Direction of force needed to open the lid

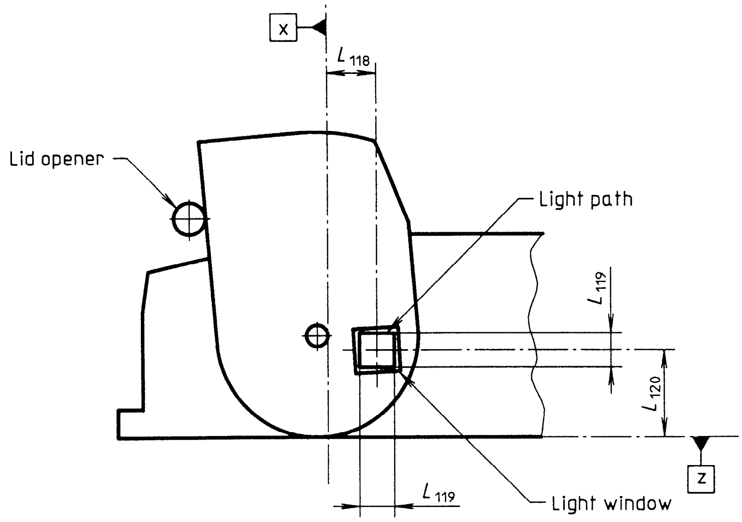

Figure 15 - Light path and light window

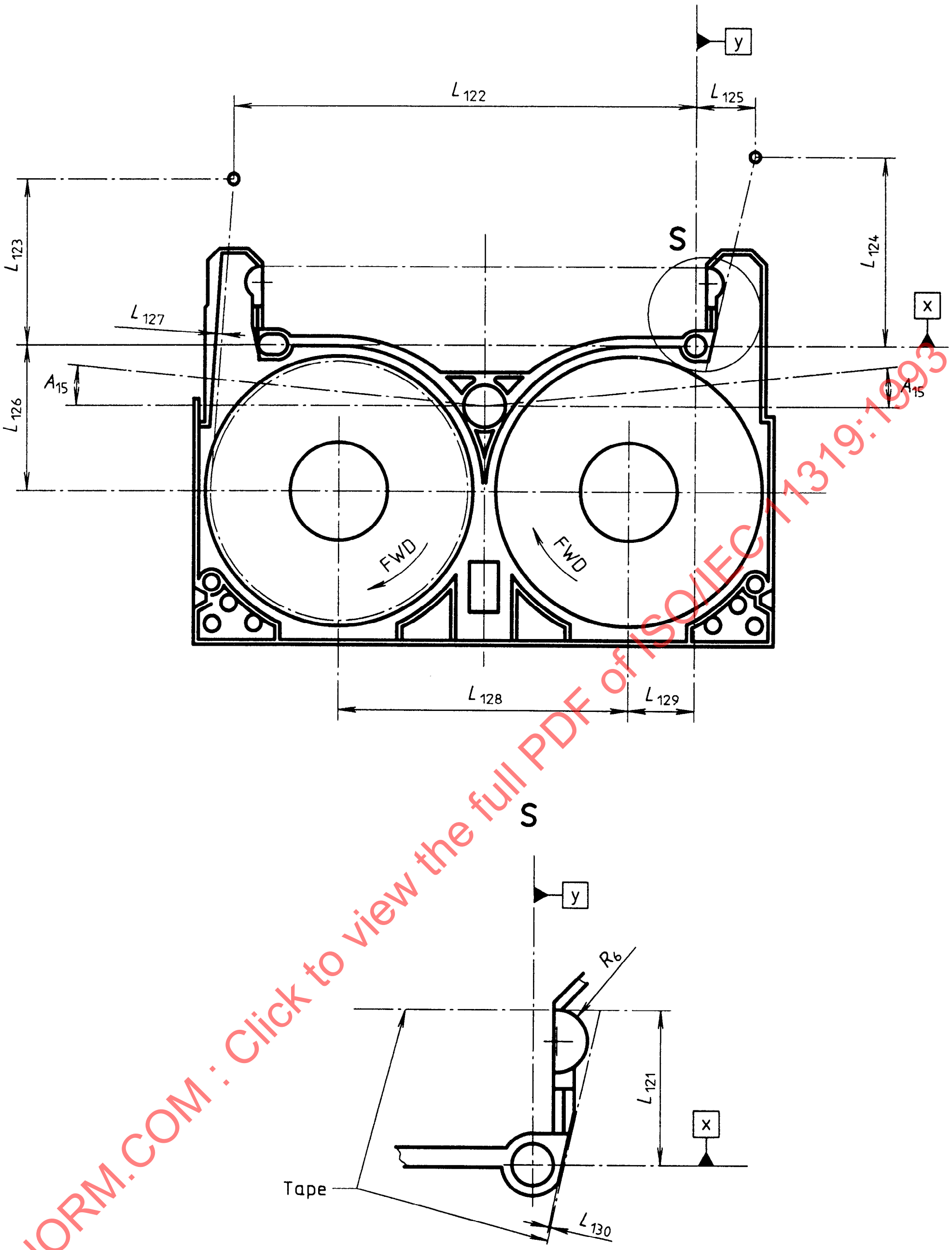

Figure 16 - Internal tape path and light path

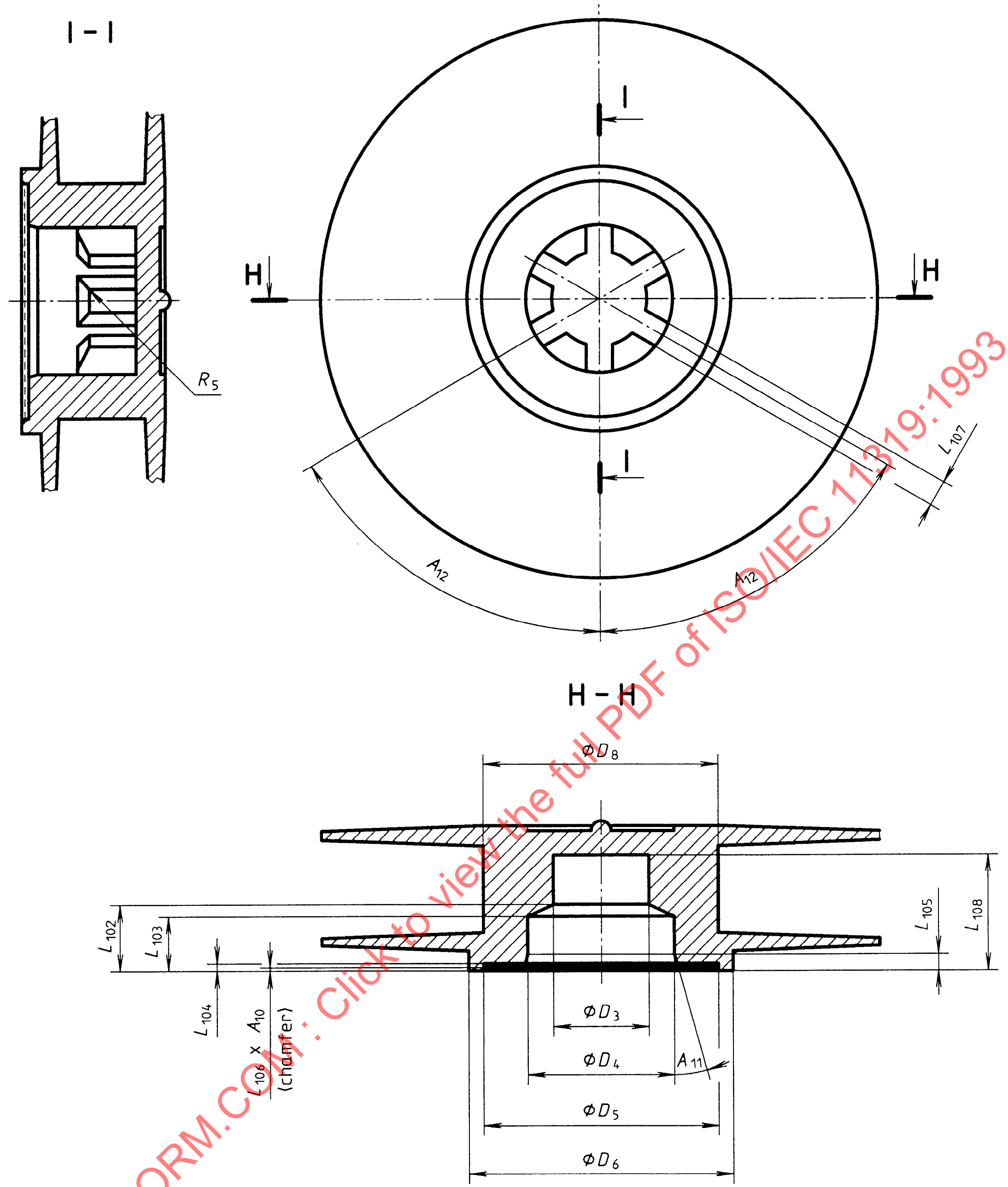

Figure 17 - Cartridge reel

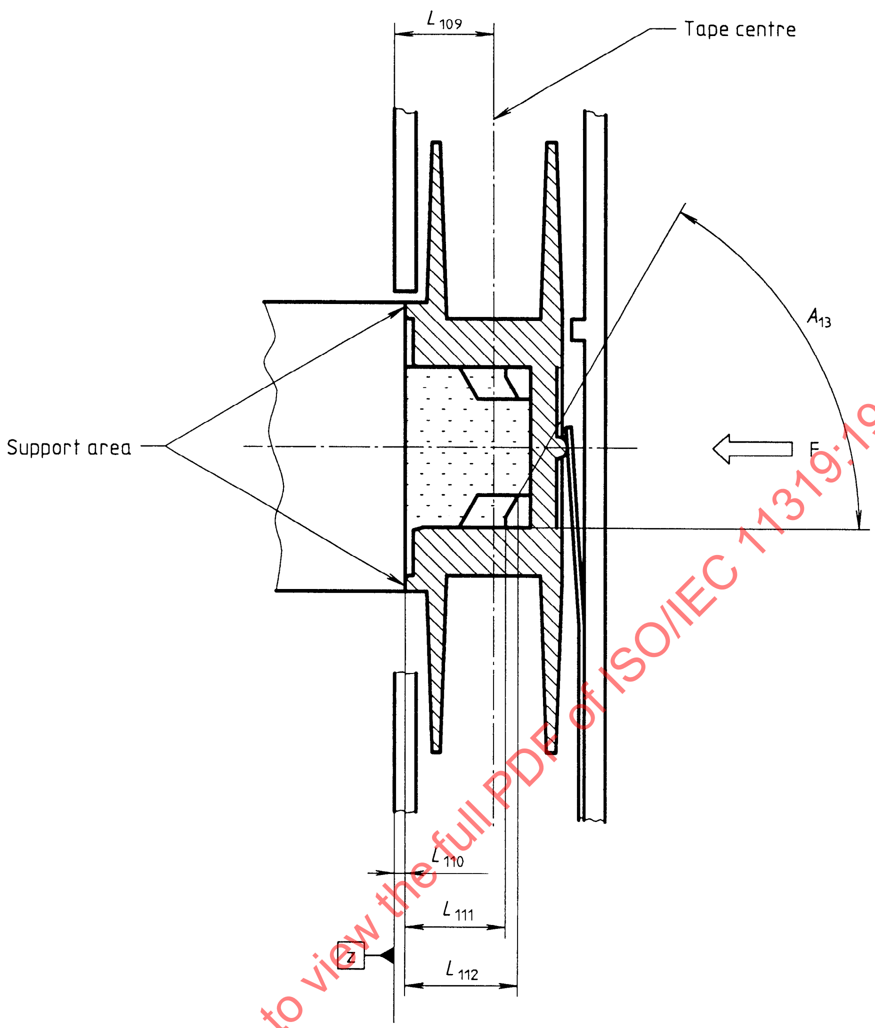

Figure 18 - Interface with drive spindle

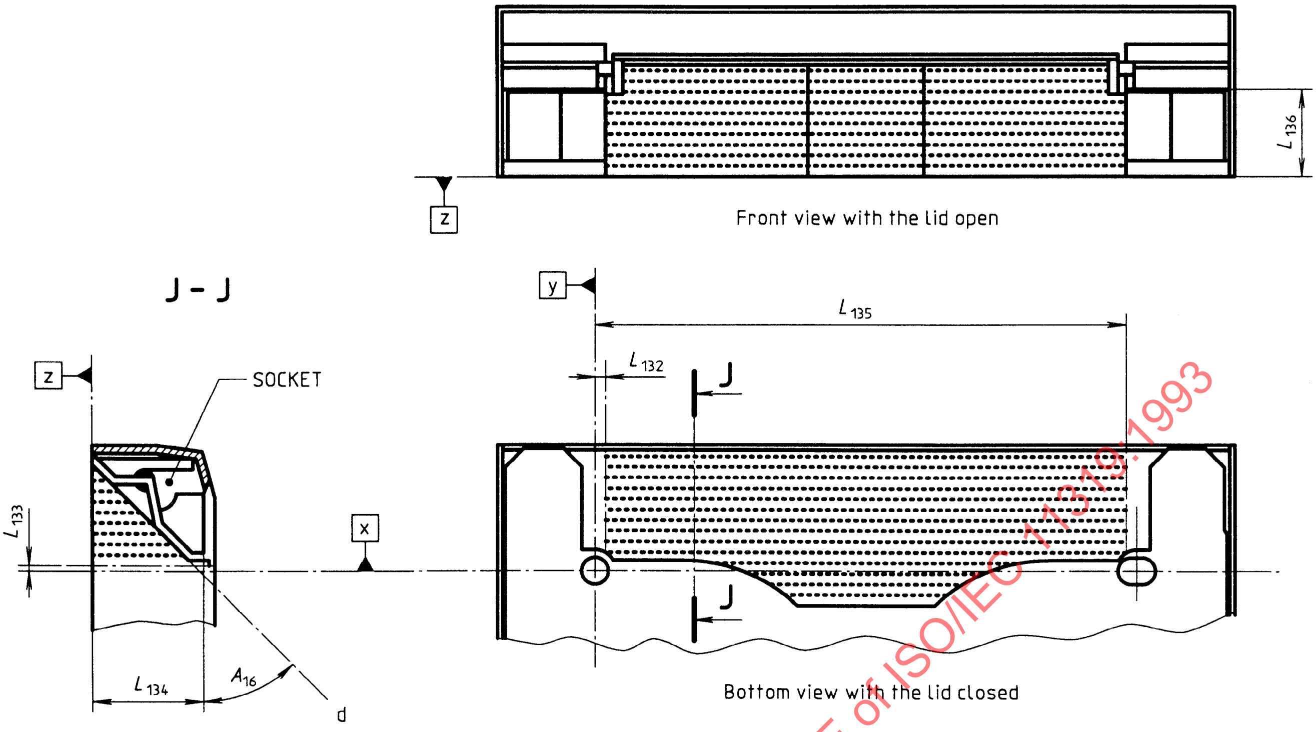

Figure 19 - Tape access cavity clearance

Section 3 : Requirements for the unrecorded tape

7 Mechanical, physical and dimensional characteristics of the tape

7.1 Materials

The recordable area of the tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one side with a strong yet flexible layer of ferromagnetic material. The back surface of the tape may be coated.

The leader and trailer tapes shall consist of a translucent length of the same or equivalent base material without the ferromagnetic coating or the back coating.

7.2 Tape length

7.2.1 Length of magnetic tape

The length of tape between PBOT and PEOT shall be 14,72 m minimum and 113 m maximum.

7.2.2 Length of leader and trailer tapes

The length of the leader and trailer tapes shall be 70 mm minimum and 90 mm maximum.

7.2.3 Splicing tape

The splicing tape shall have a maximum length of 13 mm.

7.3 Width

The width of the magnetic tape shall be 8,00 mm ± 0,01 mm. The difference between the largest and smallest width shall be no more than 6 µm peak-to-peak.

The width of the leader tape, trailer tape and splice shall be 8,00 mm ± 0,02 mm.

The width shall be measured across the tape from edge to edge.

Procedure : Cover a section of the tape with a glass microscope slide. Measure the width with no tension applied to the tape using a calibrated microscope, profile projector, or equivalent having an accuracy of at least 2,5 µm. Repeat the procedure to obtain tape widths at five or more different positions along a minimum tape length of 1 m. The tape width is the average of the widths measured.

7.4 Discontinuities

There shall be no discontinuities in the tape between PBOT and PEOT, such as those produced by tape splicings or perforations.

7.5 Thickness

7.5.1 Thickness of magnetic tape

This International Standard provides for two types of tape differing in thickness. The total thickness of a tape at any point shall be between 12,0 µm and 14,0 µm, or between 9,2 µm and 10,8 µm.

7.5.2 Thickness of leader and trailer tape

The thickness of the leader and trailer tape shall be between 13 µm and 17 µm.

7.6 Longitudinal curvature

The radius of curvature of the edge of the tape shall not be less than 33 m.

Procedure : Allow a 1 m length of tape to unroll and assume its natural curvature on a flat smooth surface. Measure the deviation from a 1 m chord.

The deviation shall not be greater than 3,8 mm.

This deviation corresponds to the minimum radius of curvature of 33 m if measured over an arc of a circle.

7.7 Cupping

The departure across the width of tape from a flat surface shall not exceed 0,9 mm.

Procedure : Cut a 1,0 m ± 0,1 m length of tape. Condition it for a minimum of 3 h in the test environment by hanging it so that the coated surface is freely exposed to the test environment. From the centre portion of the conditioned tape cut a test piece of length approximately 25 mm. Stand the test piece on its end in a cylinder which is at least 25 mm high with an minimum inside diameter of 8 mm. With the cylinder standing on an optical comparator measure the cupping by aligning the edges of the test piece to the reticle and determining the distance from the aligned edges to the corresponding surface of the test piece at its centre.

7.8 Coating adhesion (figure 20)

The force required to peel any part of the coating from the tape base material shall not be less than 0,96 N.

Procedure : Take a test piece of the tape approximately 380 mm long and scribe a line through the coating across the width of the tape 125 mm from one end. Using a double-sided pressure sensitive tape, attach the test piece to a smooth metal plate, with the coated surface facing the plate. Fold the test piece over 180° adjacent to, and parallel with the scribed line. Attach the metal plate and the free end of the test piece to the jaws of a tensometer such that when the jaws are separated the tape is peeled. Set the jaw separation rate to 254 mm/min. Note the force at which any part of the coating first separates from the base material. If this is less than 0,10 N, the test has failed. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 0,10 N, an alternative type of double-sided pressure tape shall be used.If the back surface of the tape is coated, repeat the above procedure for the back coating.

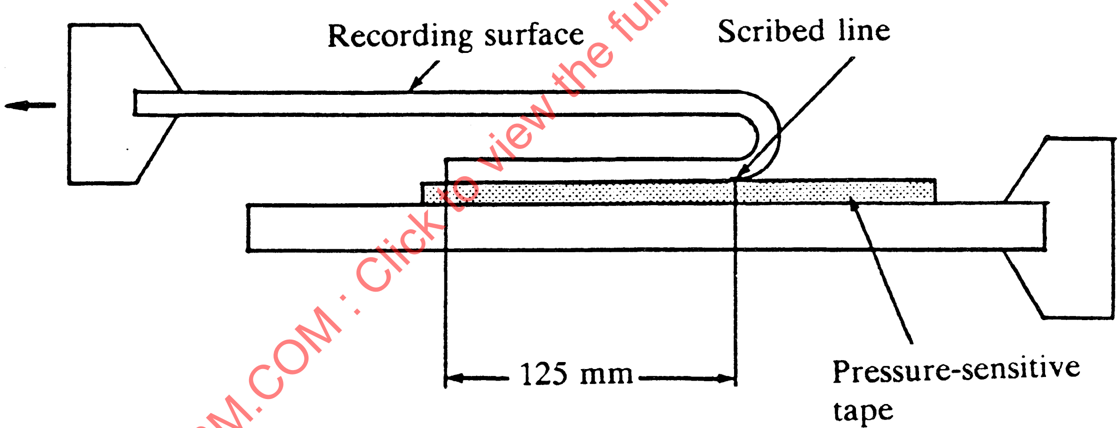

Figure 20 - Setup for measuring coating adhesion

7.9 Layer-to-layer adhesion

There shall be no tendency for the test piece to stick or for the coating to peel.

Procedure : Attach one end of a test piece of magnetic tape of 1 m in length to the surface of a glass tube of external diameter 36 mm. Wind the tape on to the tube at a tension of 1,1 N. Store the wound test piece in a temperature of 45 °C ± 3 °C and a relative humidity of 80% for 4 h. Store for a further 24 h in the testing environment. Apply a force of 0,1 N to the free end of the test piece and allow it to unwind slowly.

7.10 Tensile strength

The measurements shall be made in accordance with ISO/R 527.

The length of the test piece shall be 200 mm. The rate of elongation for all tensile tests shall be 100 mm/min (ISO/R 527, rate D).

7.10.1 Breaking strength

Load the test piece until the breaking point of the test piece is reached. The force required to reach that point is the breaking strength of the tape.

The breaking strength shall not be less than 17,6 N.

7.10.2 Yield strength

The yield strength is the force necessary to produce a 5% elongation of the tape.

The yield strength shall be greater than 4,9 N.

7.11 Residual elongation

The residual elongation, stated in per cent of the original tape length, shall be less than 0,03 %.

Procedure : Measure the initial length of a test piece of approximately 1 m with a maximum applied force of 0,20 N. Apply an additional force per total cross-sectional area of 20,5 N/mm^2 for a period of 10 min. Remove the additional force and measure the length after 10 min.

7.12 Electrical resistance of the surface

The electrical resistance of any square area of the recording surface shall be within the ranges:

$10^5\ \Omega$ to $5 \times 10^8\ \Omega$ for non-back coated tape

$10^5\ \Omega$ to $5 \times 10^{12}\ \Omega$ for back-coated tape

The electrical resistance of any square area of the back-coating, if present, shall be less than $9 \times 10^8\ \Omega$.

Procedure : Condition a test piece of tape in the test environment for 24 h. Position the test piece over two 24-carat gold-plated, semicircular electrodes having a radius r = 10 mm and a finish of at least N4, so that the recording surface is in contact with each electrode. The electrodes shall be placed parallel to the ground and parallel to each other at a distance d = 8 mm between their centres. Apply the force necessary to produce a tension of 5 N/mm^2 to each end of the test piece. Apply a d.c. voltage of 100 V ± 10 V across the electrodes and measure the resulting current flow. From this value, determine the electrical resistance. Repeat for a total of five positions along the test piece and average the five resistance readings. For back-coated tape repeat the procedure with the back-coating in contact with the electrodes. When mounting the test piece ensure that no conducting paths exist between the electrodes except that through the coating under test.

NOTE 4 Particular attention should be given to keeping the surfaces clean.

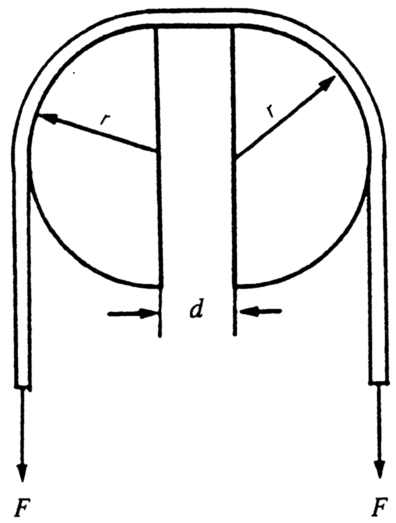

Figure 21 - Setup for measuring electrical resistance

7.13 Tape winding

The magnetic recording surface of the tape shall face outward from the cartridge and reels.

7.14 Light transmittance of tape

The light transmittance of the magnetic tape shall be less than or equal to 5 %.

The light transmittance of the leader and trailer tapes shall not be less than 60 %.

The method for measuring light transmittance is given in annex A.

8 Magnetic recording performance

The magnetic recording performance is defined by the testing requirements given in the following subclauses. When performing these tests, the head output or the resultant amplified signal shall be measured on the same relative pass for both a tape calibrated to the Secondary Reference Tape and the tape under test (read-while-write, or on equipment without read-while-write capability, on the first-forward-read-pass) on the same equipment.

8.1 Test conditions

The following conditions shall apply to all magnetic recording testing requirements, unless otherwise noted:

Tape condition:	AC erased to 2 % or less of the Average Signal Amplitude recorded at 2 126 ftpmm
Tape/head speed:	3,759 m/s ± 0,20 %
Track width:	25 µm ± 1 µm
Azimuth:	-10,000° ± 0,133°
Gap Length:	0,30 µm ± 0,05 µm

Tape Tension: 0,117 0 N ± 0,009 8 N

Recording Current: Test Recording Current

8.2 Typical Field

The Typical Field of the tape shall be between 80% and 120% of the Secondary Reference Field.

8.3 Signal Amplitude

The Average Signal Amplitude, exclusive of missing pulses, at the recording density of 2 126 ftpmm shall be between 70% and 130% of the Standard Reference Amplitude.

8.4 Resolution

The resolution of the tape shall be between 80% and 120% of that for the Secondary Standard Reference Tape when measured at the recording densities of 708,67 ftpmm and 2 126 ftpmm.

8.5 Narrow-band signal-to-noise ratio

The narrow-band signal-to-noise ratio (NB-SNR) is the average read signal power divided by the average integrated (side-band) rms noise power, and is expressed in decibels.

8.5.1 Requirement

The NB-SNR shall not be less than 34 dB when normalized to a track width of 25 μm. The normalization factor is $dB(25) = dB(W) + 10 \lg 25/W$, where W is the track width used when measuring $dB(W)$.

8.5.2 Procedure

The NB-SNR shall be measured using a spectrum analyzer. The spectrum analyzer resolution bandwidth (RBW) shall be 3 kHz and the video bandwidth (VBW) shall be 30 Hz.

Measure the read signal amplitude of the 2 126 ftpmm signal using a spectrum analyzer, taking a minimum of 150 samples over a minimum length of tape of 6 m. On the next pass (read only), measure the rms noise power over the same section of tape and integrate the rms noise power (normalizing for the actual resolution bandwidth) over the range from 3,59 MHz to 3,96 MHz.

8.6 Ease of erasure

When a tape has been recorded at 98 ftpmm with a recording current equal to the Test Recording Current for 2 126 ftpmm and passed through a longitudinal steady erasing field of 320 000 A/m any remaining signal shall not exceed 2% of the Standard Reference Amplitude. The erasure field shall be reasonably uniform, for example, the field in the middle of a solenoid. This measurement shall be made with a band pass filter passing, at least, the first three harmonics.

8.7 Tape quality

8.7.1 Missing pulses

A missing pulse is a loss of read signal amplitude. A missing pulse exists when the base-to-peak read signal is 25%, or less, of half the Average Signal Amplitude for the recording density of 2 126 ftpmm on the same tape.

8.7.2 Missing pulse zone

A missing pulse zone commences with seven consecutive missing pulses and ends when 28 consecutive flux transitions are read or when a length of 0,038 mm of track has been measured. Any further missing pulse results in a further missing pulse zone.

A missing pulse zone does not continue from one track to another.

The average missing pulse zone rate is the total number of missing pulse zones divided by the total number of flux transitions recorded on the tape.

At a density of 2 126 ftpmm, the rate of the average missing pulse zone shall be less than 2×10^{-7}.

8.8 Inhibitor tape

This International Standard does not specify parameters for assessing whether or not a tape is an inhibitor tape. However, annex E gives further information on inhibitor tapes.

Section 4 : Requirements for an interchanged tape

9 Format

9.1 General

Data to be recorded is sent from a host computer to the tape system. The tape system combines this data with additional data into groups before recording onto the tape.

In the following description all operations on the data received from the host computer, including the use of error detecting and correcting codes, are described. Then the method of recording on the tape and the tape layout itself is described. However, because of the inherent characteristics of this format, where required, advance reference to the tape layout will also be made in the course of the description of the operations on the data.

9.2 Information matrix

The data received from the host shall be allocated to a two dimensional group called an Information Matrix.

The Information Matrix shall be a 60-column by 24-row array containing 1 440 cells. Each cell is identified by its column and row numbers and contains a data byte.

When complete an Information Matrix shall contain

ID Information	14 bytes	see clause 14.
User Data bytes Pad bytes	1 024 bytes	see 9.2.1.1
CRC bytes	2 bytes	see 9.2.1.2
Horizontal EC bytes	160 bytes	see 9.2.1.3.1
Vertical EC bytes	240 bytes	see 9.2.1.3.2
	1 440 bytes	

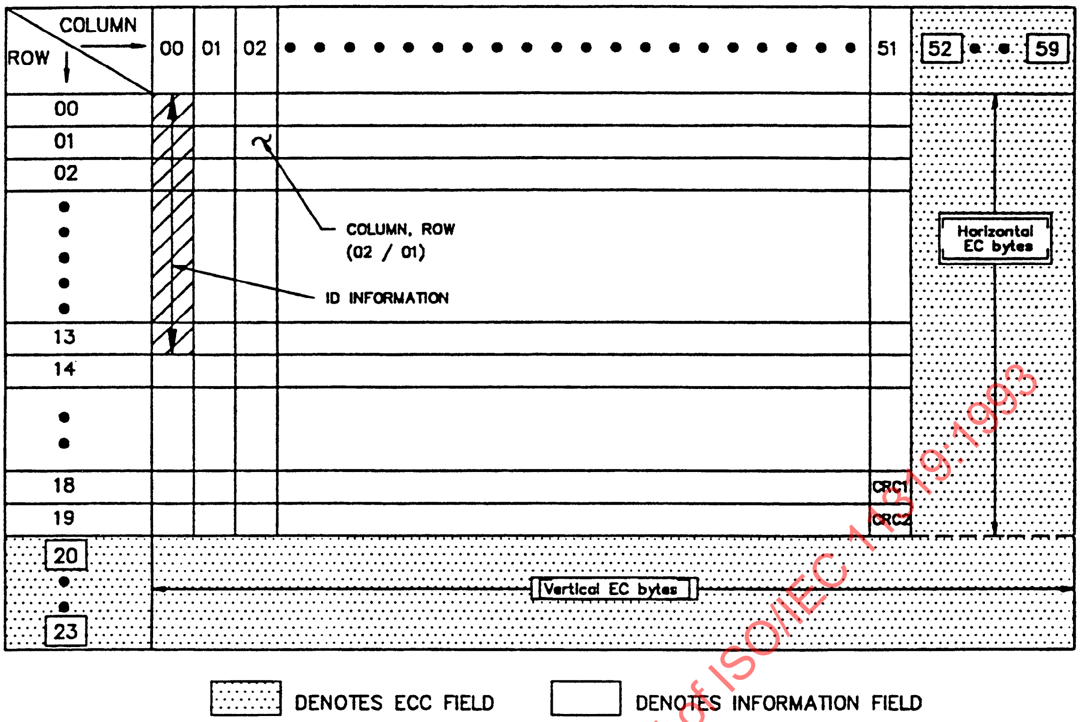

Figure 22 - Information matrix

9.2.1 Loading of the information matrix

Cells are identified by column and row in the following form: 00/00 to 59/23. All additions in the calculations of the CRC bytes and EC bytes are Exclusive OR operations.

9.2.1.1 Group 1 (G1)

A G1 Group shall consist of 1 038 bytes, viz 14 bytes of ID Information and other 1 024 bytes. When the number of available User Data bytes is less than 1 024, the remaining bytes are Pad bytes. These bytes are undefined and shall be ignored for interchange. Some G1 Groups contain no User Data bytes (see 12.3).

ID Information shall be entered into cells 00/00 to 00/13. The content of these bytes are specified in clause 14.

User Data bytes from the host shall be entered sequentially by column starting with 00/14 to 00/19, continuing with 02/00 to 02/19 through the even columns until 50/19, then returning to 01/00 to 01/19 and continuing through the odd columns until 51/17.

9.2.1.2 Group 2 (G2)

A G2 Group shall consist of a G1 Group with the addition of two CRC bytes.

The two CRC bytes shall be computed over the 1 038 bytes of the G1 Group and entered into cells 51/18 and 51/19.

They are generated as follows:

D_k is the byte in column c and row r

where:

k = 0 to 1037

k = (10c + r), if c is even

k = (10c + r + 510), if c is odd

c = 0 to 51

r = 0 to 19

$D_{k,0}$, $D_{k,1}$,..., $D_{k,7}$ denote the 8 bits of D_k, where $D_{k,7}$ is the high order bit.

$$D_k(X) = \sum_{j=0}^{j=7} D_{kj}\, x^j$$

$$D(X) = \sum_{k=0}^{k=1\,037} D_k(X)\, x^{8(1\,039-k)}$$

$$G_{CRC}(X) = x^{16} + x^{12} + x^5 + 1$$

$$C(X) = D(X) \bmod G_{CRC}(X)$$

$$C(x) + x^{14} + x^{12} + x^{10} + x^8 + x^7 + x^5 + x^3 + x = \sum_{k=0}^{k=7} (CH_k\, x^{k+8} + CL_k\, x^k)$$

where

CH_0, CH_1, ... , CH_7 are the bits of the first CRC byte (CRC1), CH_7 being the most significant bit;

CL_0, CL_1, ... , CL_7 are the bits of the second CRC byte (CRC2), CL_7 being the most significant bit.

9.2.1.3 ECC

For the Error-Correcting Code (ECC) the (30, 26, 5) Reed-Solomon code is used for the horizontal code, and the (24, 20, 5) Reed-Solomon code is used for the vertical code. This yields two types of check bytes:

- Horizontal EC bytes
- Vertical EC bytes

T[A] denotes a linear transformation on the 8-bit byte A.

T^{-1} [B] denotes the inverse transformation and defines the transformation in the following way:

B = T[A] and A = T^{-1} [B]

A_0, A_1, ... , A_7 are the 8 bits of A (A_7 being the most significant bit) and B_0, B_1, ... , B_7 the 8 bits of B (B_7 being the most significant bit.)

These transformations are defined by the following:

$B_0 = A_0 + A_2 + A_3 + A_5 + A_7$
$B_1 = A_3 + A_4 + A_6 + A_7$
$B_2 = A_0 + A_6 + A_7$
$B_3 = A_0 + A_1 + A_6$
$B_4 = A_1$
$B_5 = A_0$
$B_6 = A_1 + A_2 + A_3 + A_7$
$B_7 = A_0 + A_1 + A_2 + A_6$

$A_0 = B_5$
$A_1 = B_4$
$A_2 = B_3 + B_7$
$A_3 = B_2 + B_6 + B_7$
$A_4 = B_1 + B_5 + B_6 + B_7$
$A_5 = B_0 + B_4 + B_5 + B_6$
$A_6 = B_3 + B_4 + B_5$
$A_7 = B_2 + B_3 + B_4$

The field generator for GF(2^8) is

$$G_\alpha(X) = x^8 + x^4 + x^3 + x^2 + 1$$

B is an element of GF(2^8) such that :

$$B = \sum_{k=0}^{k=7} B_k \alpha^k$$

where B_0, B_1, ... , B_7 are the bits of B, B_7 being the most significant bit.

$$G(X) = \prod_{i=-1}^{i=2} (X + \alpha^i)$$

9.2.1.3.1 Group 3 (G3)

A G3 Group shall consist of a G2 Group with the addition of the Horizontal EC bytes.

$D_{c,r}$ denotes the bytes in the G2 Group, where c is the column number (0 to 51) and r is the row number (0 to 19).

$DHE_r(X)$ denotes the polynomial the coefficients of which are the transforms of the bytes in the even columns of row r. $T[CRE_{k,r}]$ denotes the transforms of the Horizontal EC bytes in the even columns of row r. $CRE_{k,r}$ denotes the Horizontal EC bytes in the even columns of row r.

$$DHE_r(X) = \sum_{k=0}^{k=25} T\left[D_{2k,r}\right] X^{29-k}$$

r = 0,1,..., 19

$$DHE_r(X) \bmod G(X) = \sum_{k=1}^{k=4} T\left[CRE_{k,r}\right] X^{4-k}$$

$$CRE_{k,r} = T^{-1}\left[T\left[CRE_{k,r}\right]\right]$$

k = 1,2,3,4

$CRE_{k,r}$ shall be the contents of the cell in column c and row r where $c = 50 + 2k$.

Similarly, $DHO_r(X)$ denotes the polynomial the coefficients of which are the transforms of the bytes in the odd columns of row r. $T[CRO_{k,r}]$ denotes the transforms of the Horizontal EC bytes in the odd columns of row r. $CRO_{k,r}$ denotes the Horizontal EC bytes in the odd columns of row r.

$$\mathrm{DHO}_r\,(X) = \sum_{k=0}^{k=25} \mathrm{T}\left[\mathrm{D}_{(2k+1),r}\right] X^{29-k}$$

r = 0,1,..., 19

$$\mathrm{DHO}_r\,(X) \bmod \mathrm{G}\,(X) = \sum_{k=1}^{k=4} \mathrm{T}\left[\mathrm{CRO}_{k,r}\right] X^{4-k}$$

$$\mathrm{CRO}_{k,r} = \mathrm{T}^{-1}\left[\mathrm{T}\left[\mathrm{CRO}_{k,r}\right]\right]$$

k = 1,2,3,4

$\mathrm{CRO}_{k,r}$ shall be the contents of the cell in column c and row r where $c = 51 + 2k$.

9.2.1.3.2 Group 4 (G4)

A G4 Group shall consist of a G3 Group with the addition of the Vertical EC bytes.

$\mathrm{D}_{c,r}$ denotes each byte in the G3 group consisting of all columns in rows 0 to 19, where c is the column number (0 to 59) and r is the row number (0 to 19).

$\mathrm{DV}_c(X)$ denotes the polynomial whose coefficients are the transforms of the bytes in column c. $\mathrm{T}[\mathrm{CC}_{c,k}]$ denotes the transforms of the Vertical EC bytes in column c. $\mathrm{CC}_{c,k}$ denotes the Vertical EC bytes in column c.

$$\mathrm{DV}_c\,(X) = \sum_{k=0}^{k=19} \mathrm{T}\left[\mathrm{D}_{c,k}\right] X^{23-k}$$

c = 0,1,..., 59

$$\mathrm{DV}_c\,(X) \bmod \mathrm{G}\,(X) = \sum_{k=0}^{k=4} \mathrm{T}\left[\mathrm{CC}_{c,k}\right] X^{4-k}$$

$$\mathrm{CC}_{c,k} = \mathrm{T}^{-1}\left[\mathrm{T}\left[\mathrm{CC}_{c,k}\right]\right]$$

k = 1,2,3,4

$\mathrm{CC}_{c,k}$ shall be the contents of the cell in column c and row r where $r = 19 + k$.

10 Method of recording

The method of recording shall be NRZ1 (non-return to ZERO, change on ONEs).

- A ONE is represented by a flux transition at the centre of a bit cell.
- A ZERO is represented by the absence of flux transitions from the bit cell.

10.1 Physical recording density

The maximum physical recording density shall be 2 126 ftpmm and occurs for a pattern of all ONEs.

The resulting nominal bit cell length is 0,470 µm.

10.1.1 Long-term average bit cell length

The long-term average bit cell length for each track shall be measured over a minimum of 133 060 consecutive bit cells. It shall be within 0,20% of the nominal bit cell length.

10.1.2 Short-term average bit cell length

The short-term average bit cell length (STA) shall be the average taken over any 16 bit cells. The short-term average bit cell length shall be within 0,35% of the long-term average bit cell length for the preceding track.

10.1.3 Rate of change

The rate of change of the short-term average flux transition cell length, taken over any two consecutive 16-bit cell lengths, shall not exceed 0,05%.

$$\left| \frac{STA_n}{16 \text{ Channel bits}} \right| \frac{STA_{n+1}}{16 \text{ Channel bits}} \right|$$

Rate of Change :

$$\frac{\left| STA_n - STA_{n+1} \right|}{STA_n} \times 100\%$$

10.2 Bit shift

The maximum displacement of any ONEs zero crossing, exclusive of missing pulses, shall not deviate by more than 25% from the expected position as defined by the average bit cell length.

See annex B for the method of measurement.

10.3 Read signal amplitudes

10.3.1 Amplitude of data signals

The signal amplitude averaged over a minimum of 3 000 flux transitions at 2 126 ftpmm shall be between 70% and 130% of the Secondary Reference Amplitude.

10.3.2 Amplitude of servo signals

The servo signal amplitude averaged over any Servo Frame (see 12.5) shall be between 70% and 130% of a 98 ftpmm signal recorded on the Secondary Standard Reference Tape with the Test Recording Current.

10.3.3 Signal amplitude on an analogue tape mark track

The signal amplitude on any Analogue Tape Mark Track (see 13.1) averaged over any recorded track length shall be between 70% and 130% of a 98 ftpmm signal recorded on the Secondary Standard Reference Tape with the Test Recording Current.

10.4 Erasure

In all erased areas the full width of the tape shall be AC erased in the direction of tape motion. After erasure, the read signal amplitude shall be no greater than 2% of the Average Signal Amplitude recorded at the physical recording density of 2 126 ftpmm on the same tape.

11 Track geometry

11.1 Track positions

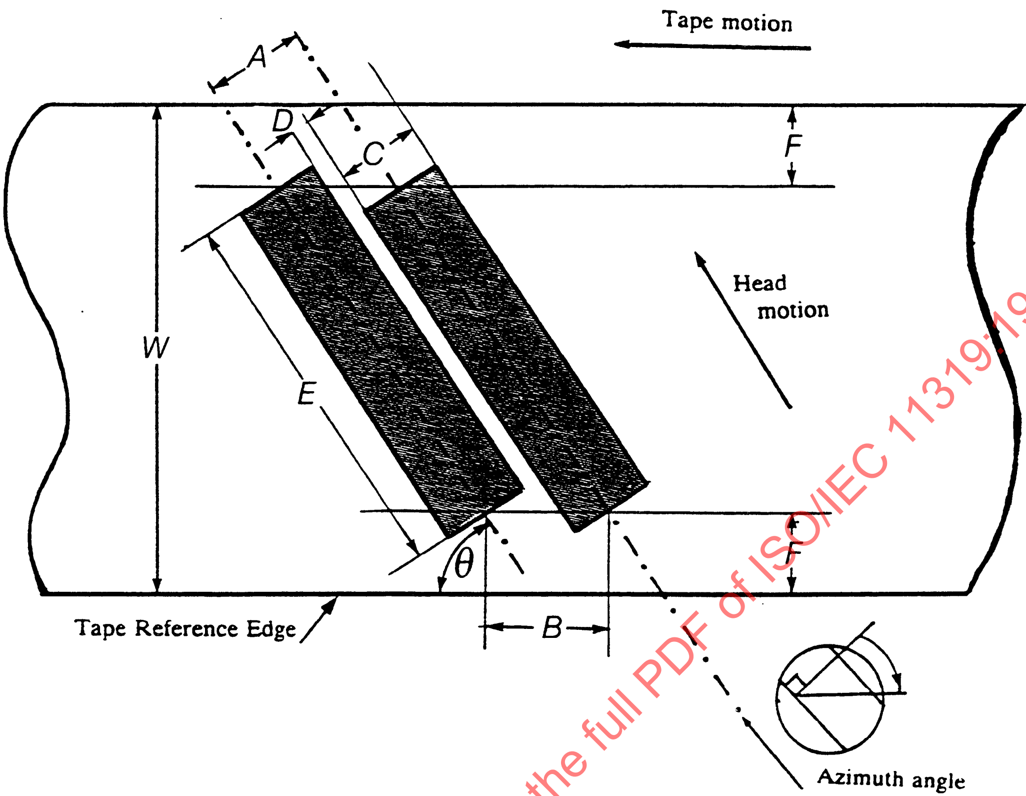

Figure 23 - Track layout and track location

A :	Adjacent Track Pitch
B :	Longitudinal Track Pitch
C :	Track Width
D :	Track Guard Band
E :	Track Length
F :	Guard Band
W :	Tape Width
θ :	Track Angle

Each recorded track shall have a length E = 71,673 mm ± 0,144 mm.

There shall be a Guard Band of width F = 1,014 mm ± 0,018 mm extending from the Tape Reference Edge to the start of the recorded tracks.

There shall be an erased Track Guard Band between adjacent tracks. The width D of this Track Guard Band shall be 6,0 μm ± 2,5 μm.

11.2 Track pitch

11.2.1 Average track pitch

The distance, averaged over any group of 30 consecutive tracks, between the centreline of any track and the centreline of an adjacent track, measured perpendicular to the track length, shall be between 0,030 8 mm and 0,031 2 mm.

NOTE 5 The corresponding average longitudinal distance B measured parallel to the Reference Edge of the tape is 0,363 mm nominal.

11.2.2 Adjacent track pitch

The distance A between the centrelines of any two adjacent tracks, measured perpendicular to the track length, shall be between 0,029 5 mm and 0,032 5 mm.

11.3 Track width

The width C of a written track shall be 25 µm ± 1 µm.

11.4 Track angle

The angle θ of the centreline of each track in degrees of arc relative to the reference edge shall be 4,899 1° ± 0,001 5°.

11.5 Linearity of track edges

The edges of a recorded track shall each be contained within two parallel straight lines 5 µm apart.

11.6 Azimuth

The azimuth shall be -10,000° ± 0,133°

12 Format of an information track

12.1 Channel bit

A Channel bit occupies a bit cell.

The Bit Synchronization field, Servo Zone, Preamble, Postamble, and Analogue Tape Mark Track are specified in Channel bits.

Each Information Segment Number is represented by a pattern of 10 Channel bits (see 12.2.2).

Each 8-bit byte in the Information Segment field is represented by a pattern of 10 Channel bits as defined in annex C.

12.2 Information Segment

An Information Segment shall be structured as shown in figure 24.

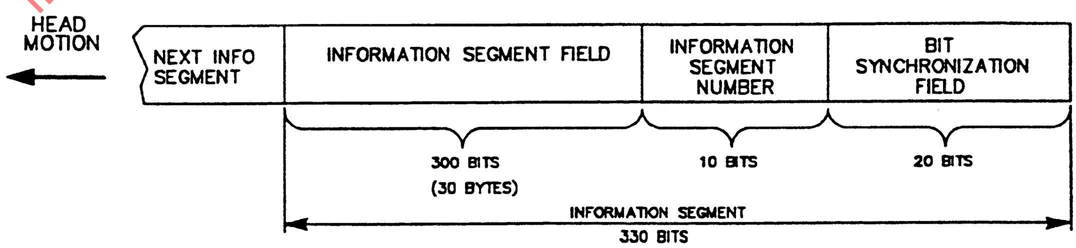

Figure 24 - Information Segment layout

12.2.1 Bit Synchronization field

The Bit Synchronization field shall be a 20-bit pattern comprising a leading ZERO, eighteen ONEs, and a trailing ZERO.

12.2.2 Information Segment Number

An Information Segment Number in the range of 00 to 47 shall be represented by a 10-bit pattern as defined in table 1. The highest bit position of the Information Segment Number shall be recorded first.

Table 1 - Information Segment Number

INFORMATION SEGMENT NUMBER	RECORDED PATTERN	INFORMATION SEGMENT NUMBER	RECORDED PATTERN
00	1111111011	24	1101111111
01	1111111101	25	1101111101
02	1111110111	26	1101110111
03	1111110101	27	1101110101
04	1110111011	28	1011011111
05	1110111101	29	1011011101
06	1110110111	30	1011010111
07	1110110101	31	1011010101
08	1101011011	32	1110111111
09	1101011101	33	1111101111
10	1101010111	34	1111101101
11	1101010101	35	1111101011
12	1011111011	36	1101011111
13	1011111101	37	1110101111
14	1011110111	38	1110101101
15	1011110101	39	1110101011
16	1010111011	40	1010111111
17	1010111101	41	1011101111
18	1010110111	42	1011101101
19	1010110101	43	1011101011
20	1111011111	44	1011111111
21	1111011101	45	1010101111
22	1111010111	46	1010101011
23	1111010101	47	1101101011
	10 1		10 1
	BIT POSITION		

12.2.3 Information Segment field

The Information Segment field shall consist of 300 Channel bits representing 30 data bytes unloaded from the Information Matrix. Each row (R) of the Information Matrix shall be divided into two Information Segment fields, 00/R to 29/R and 30/R to 59/R. These shall be numbered as shown in figure 25. They shall be unloaded in this sequence.

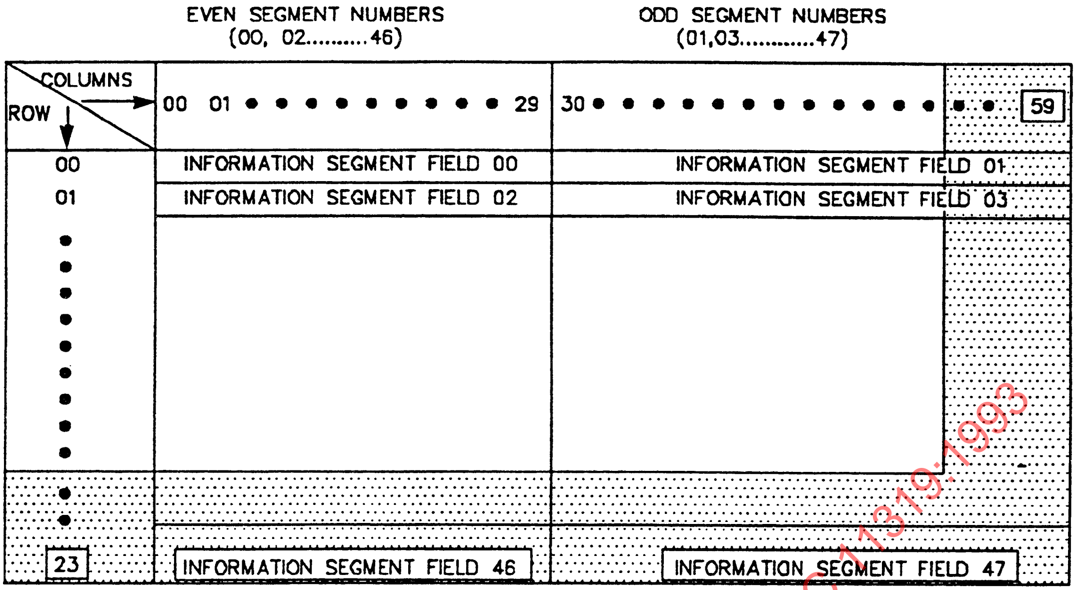

Figure 25 - Segment field partitioning of the Information Matrix

12.3 Information Block

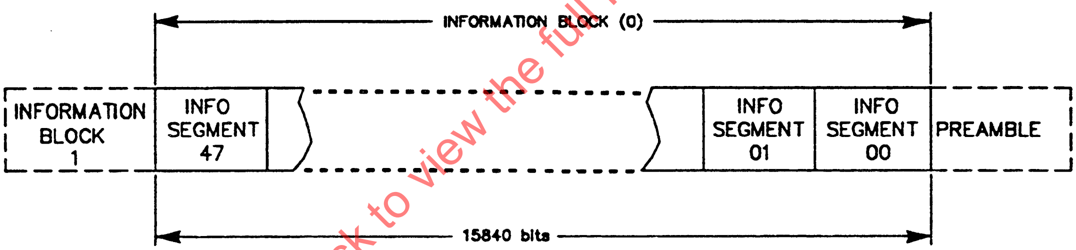

Figure 26 - Information Block layout

An Information Block shall consist of 48 Information Segments numbered sequentially from 00 to 47. Information Segment 00 shall be recorded first.

There are four types of Information block: Data Block, Pad Block, Format ID Block and Tape Mark Block. They are identified in the ID Information (see clause 14.).

The bytes in the G1 Group, exclusive of the ID Information, of the Pad Block, of the Format ID Block and of the Tape Mark Block, are undefined and shall not be used for interchange.

12.4 Information Zone

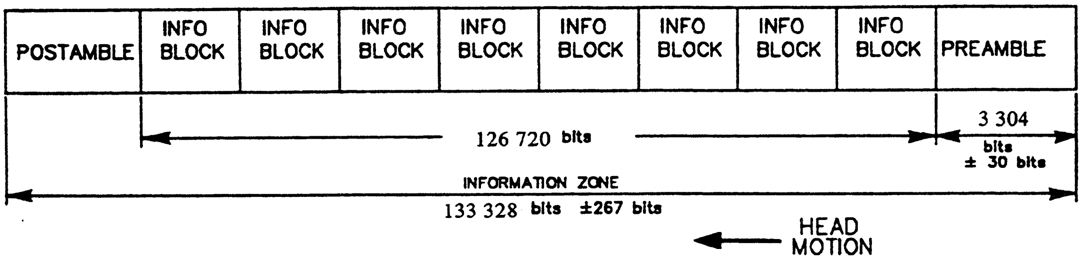

Figure 27 - Information area layout

An Information Zone shall consist of a Preamble, eight Information Blocks and a Postamble, and shall have a length of 133 328 Channel bits ± 267 Channel bits.

The Preamble shall consist of a sequence of 3 304 ± 30 ONE Channel bits.

The Postamble shall consist of a sequence of ONE Channel bits. The number shall be such that the total of 133 328 Channel bits ± 267 Channel bits in the Information Zone is maintained.

12.5 Servo Zone

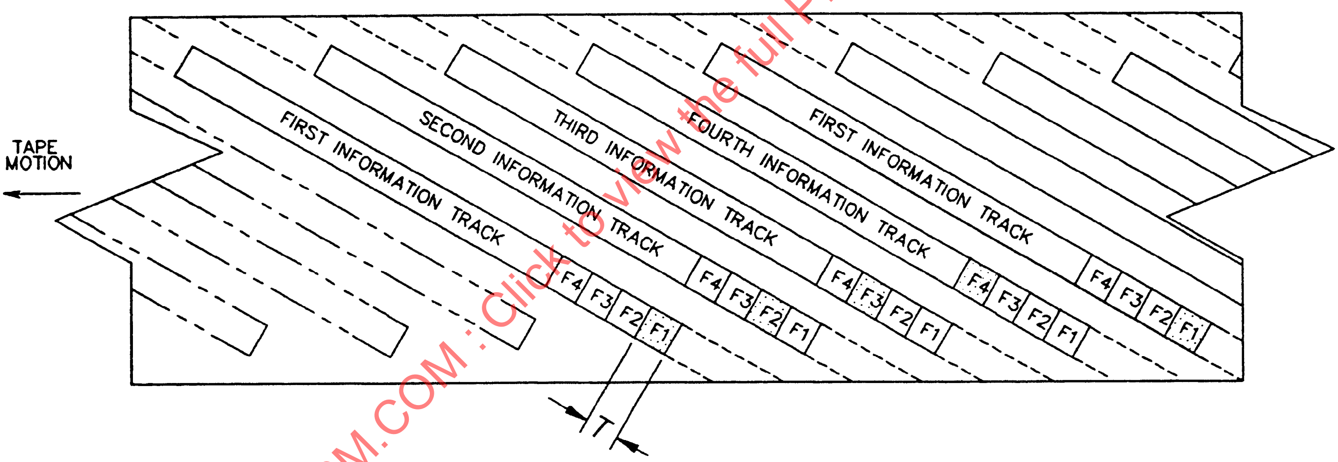

Figure 28 - Servo Zone layout

The Servo Zone is used for the proper positioning of the head relative to the recorded track. It shall consist of four Servo Frames F1 to F4, each of which has a nominal length T of 2,256 mm.

Within a Servo Zone only one of the four Servo Frames shall be recorded; it shall be filled with Tone. The Servo Frame to be recorded in the first track after an erased zone is not defined, but in successive tracks the position of the recorded Servo Frame shall be advanced by one frame in the direction of head motion. When Servo Frame F4 has been recorded in a track, Servo Frame F1 shall be recorded in the next track and the sequence repeated.

12.6 Information Tracks

All Information Tracks shall contain a Servo Zone followed by an Information Zone.

There are four types of Information Tracks.

- the Format ID Tracks;
- the Data Tracks;
- the Tape Mark Tracks;
- the Splice Tracks.

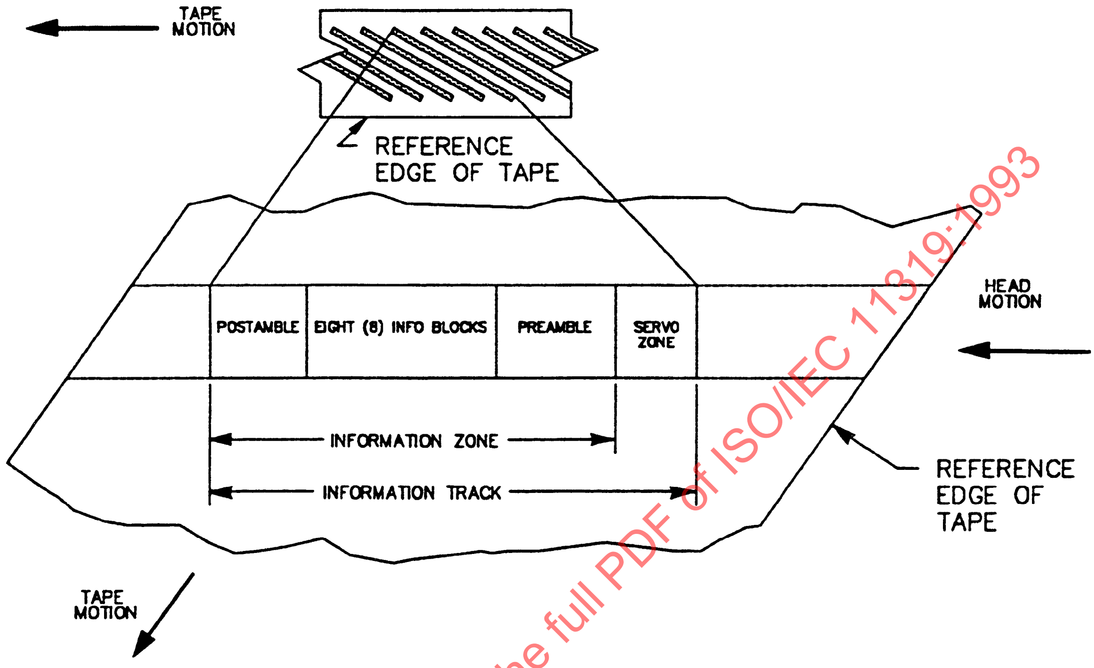

Figure 29 - Information Track

12.6.1 Format ID Track

The Information Zone of a Format ID Track shall consist of Format ID Blocks. Physical Block ID Numbers shall be assigned in ascending order to all blocks in every track, regardless of whether or not the track is recorded (see 14.9). The first Format ID Block of the first Format ID Track shall contain a Physical Block ID Number 0. The end of the LBOT area is at the conclusion of the 160th Format ID Track. The eighth block of the 160th Format ID Track shall contain the Physical Block ID Number [(160 x 8) - 1] = 1 279.

12.6.2 Data Track

The Information Zone of a Data Track shall consist of Data Blocks and/or Pad Blocks.

12.6.3 Tape Mark Track

The Information Zone of a Tape Mark Track shall consist of Tape Mark Blocks.

12.6.4 Splice Track

The Information Zone of a Splice Track shall consist of Pad Blocks. Whenever tape motion is halted during a write operation, a Splice Track shall be the last track recorded. Splice Tracks, when recorded, shall be recorded adjacent to Data Tracks, other Splice Tracks, or following a Tape Mark.

13 Tape Mark

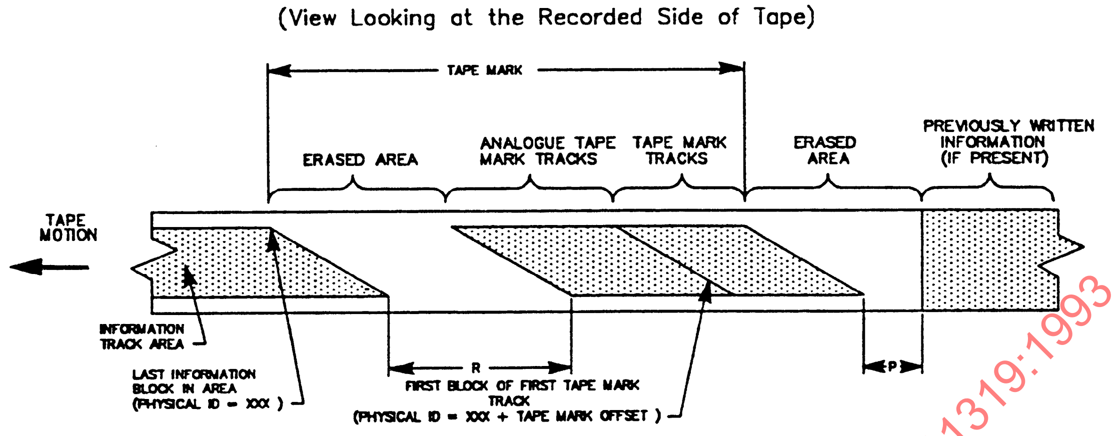

Figure 30 - Tape Mark layout

13.1 Description

Tape Marks may be used to delimit groups of recorded user data. There are two types of Tape Marks.

- A Long Tape Mark - Block Type (FA)
- A Short Tape Mark - Block Type (FB)

Both Tape Marks shall consist of a full width AC-erased area extending from the last written track for a distance dependent upon the type of Tape Mark, followed by 11 Analogue Tape Mark Tracks and 10 to 18 Tape Mark Tracks.

An Analogue Tape Mark Track shall consist of a Servo Zone followed by Tone extending over the entire Information Zone.

The first block of the first Tape Mark Track shall be recorded with the Physical Block ID Number equal to the Physical Block ID Number of the last Information Block plus the Tape Mark offset.

The nominal distance *R* is the distance between the centres of the two tracks bounding the erased area.

13.2 Long Tape Mark

The erased area shall extend for a nominal distance of 90,75 mm. This corresponds to 249 erased tracks. The Offset is [(249 + 11) x 8] + 1 = 2 081.

13.3 Short Tape Mark

There are two types of Short Tape Mark: a Normal Short Tape Mark and an Alternative Short Tape Mark.

13.3.1 Normal Short Tape Mark

The erased area shall extend for a nominal distance of 14,52 mm. This corresponds to 39 erased tracks. The Offset is [(39 + 11) x 8] + 1 = 401 .

13.3.2 Alternative Short Tape Mark

The erased area shall extend for a nominal distance of 1,089 mm. This corresponds to 2 erased tracks. The Offset is [(2 + 11) x 8] + 1 = 105 .

14 ID Information

Each of the eight Physical Blocks of an Information Track contains 14 bytes of ID Information. These bytes are supplied and used by the tape sub-system for management of the sub-system. Within the Information Matrix field, Rows 00 to Row 13, all within Column 00 shall contain information pertaining to the Logical and Physical partitioning of User Data Blocks, Block Type, Rewrite Count, Start/End Logical Block Flags, and other subsystem control information.

14.1 Column 00, Row 00

The purpose of this byte is dependent upon the block type. The block type is specified in Column 00 Row 03.

14.1.1 Block Type - Data Block

If the block type is a Data Block then this byte shall have the following bit significance:

bit 7	shall be set to ONE
bit 6	This bit is used in the mapping of Logical Blocks to Physical Blocks. It signifies the start of a Logical Block within this Physical Block. This bit shall be set to ONE if, and only if, the first byte of a Logical Block is contained in this Physical Block, else it shall be set to ZERO.
bit 5	This bit is also used in the mapping of Logical Blocks to Physical Blocks. It signifies the end of a Logical Block within this Physical Block. This bit shall be set to ONE if, and only if, the last byte of a Logical Block is contained in this Physical Block, else it shall be set to ZERO.
bit 4	shall be set to ZERO
bits 3,2,1,0	These bits shall specify in binary notation the number modulo 16 of rewrites for this Logical Block. This number shall be 0 when the block is recorded the first time. For each rewrite this number shall be incremented by 1.

14.1.2 Block type - Tape Mark

If the block type is a Tape Mark then this byte shall specify in binary notation the number modulo 256 of Tape Marks recorded on this tape volume previous to the current Tape Mark.

14.1.3 Block type - Format ID

If the block type is a Format ID Block then the content of this byte shall be set to (00).

14.1.4 Block type - Pad Block

If the block type is a Pad Block, the contents of this byte shall be undefined and shall be ignored for interchange.

14.2 Column 00, Row 01

This byte shall be set to (00) for all block types.

14.3 Column 00, Row 02

This byte shall be set to (00) for all block types.

14.4 Column 00, Row 03

This byte defines the type of block. The Block Type ID shall be as follows:

(00) to (F7) = Data Blocks
(F8) = Reserved for future use
(F9) = Reserved for future use
(FA) = Long Tape Mark
(FB) = Short Tape Mark

(FC) = Format ID
(FD) = Reserved for future use
(FE) = Pad Block
(FF) = Reserved for future use

The Block Type ID for the first Data Block after LBOT or a Tape Mark shall be (00). The Block Type ID shall increase continuously from (00) to (F7) and shall then restart at (00). The Block Type ID shall be reset after a Tape Mark.

14.5 Column 00, Row 04

This byte shall be set to (00) for all block types.

14.6 Column 00, Rows 05, 06

The purpose of these bytes is dependent upon the block type. The block type is defined in Column 00 Row 03.

If the block type is not a Data Block then the content of these bytes shall be undefined and ignored for interchange.

14.6.1 Row 05

If the block type is a Data Block then this byte shall contain the high order byte of a two-byte count representing the byte count of the User Data contained in this Physical Block. The content of this byte shall be in the range (00) to (03).

14.6.2 Row 06

If the block type is a Data Block then this byte shall contain the low order byte of a two-byte count representing the byte count of the User Data contained in this Physical Block. The content of this byte shall be in the range (00) to (FF). A high order byte content (00) and a low order byte content (00) shall represent a one-byte logical byte count.

14.7 Column 00, Row 07

This byte shall be set to (00) for all block types.

14.8 Column 00, Rows 08, 09, 10

The purpose of these bytes is dependent upon the block type. The block type is defined in Column 00, Row 03.

14.8.1 Block type - Data Block

If the block is a Data Block then these bytes represent the high order, the middle order and the low order bytes, respectively, of a 3-byte count representing the Logical ID number of this Logical Block. The content of each byte shall be in the range (00) to (FF). The Logical Block ID Number begins at 0 for the first Logical Block after LBOT or a Tape Mark and shall be incremented by 1 for each subsequent Logical Block.

As a Logical Block may extend over more than one Data Block, more than one Data Block may contain identical Logical Block ID Numbers.

14.8.2 Block type - non-Data Block

If the block type is not a Data Block then the content of these bytes shall be undefined and ignored for interchange.

14.9 Column 00, Rows 11, 12, 13

For all block types, these bytes represent the high order, the middle order and the low order bytes, respectively, of a 3-byte count representing the Physical ID Number of this block. The content of each byte shall be in the range (00) to (FF). The first block of the first Format ID Track shall contain the Physical Block ID Number 0. The number shall be incremented by 1 for each subsequent Information Block and by 8 for each erased track and each Analogue Tape Mark Track.

15 Rewritten Information Blocks

When Information Blocks are rewritten, the ID Information of the rewritten block shall be identical with that of the original block, with the exception of the rewrite count and the Physical Block ID Number which represents the actual location of the rewritten block (see 14.1.1 and 14.9). The maximum displacement of a rewritten Information Block from its initial location shall be 121 Information Blocks. To ensure recorded data reliability, the quality of recorded blocks shall be such that no more than two segments of any recorded block contain missing pulse zones.

16 Physical tape format

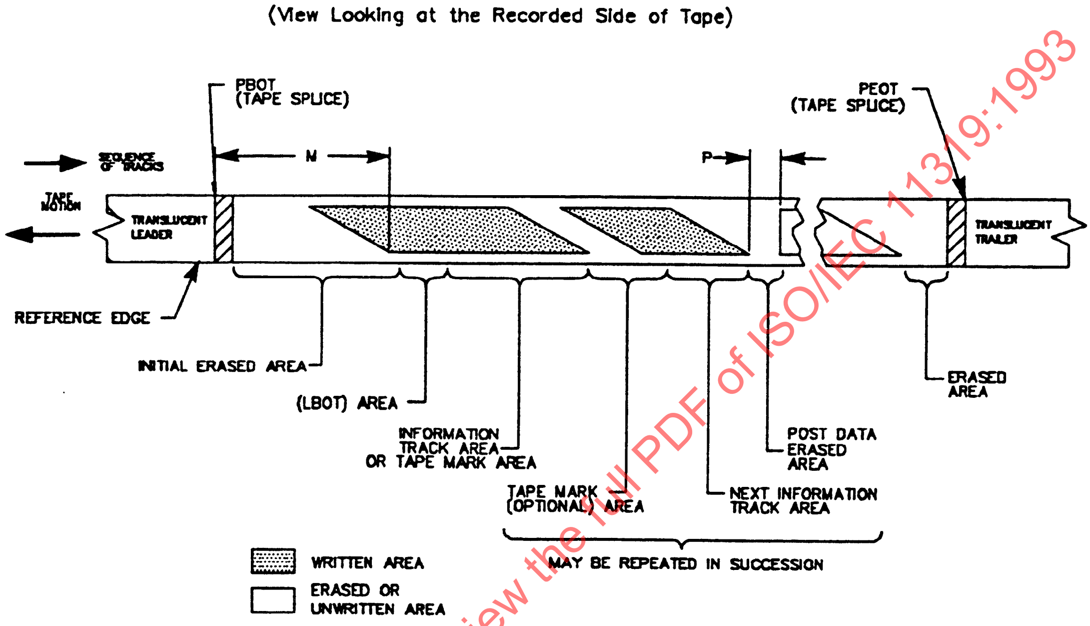

Figure 31 - Tape layout

16.1 Initial Erased Area

The Initial Erased Area shall commence with PBOT and extend for a distance M along the tape of 725,0 mm minimum and 745,0 mm maximum. It is terminated by the beginning of the LBOT Area.